



CANINE OSTEOARTHRITIS

21 June 2009

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125 North Terrace, Adelaide, SA

Proceedings 377



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Speaker Profile

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Chris Preston is a registered specialist in small animal surgery and runs a stand alone referral practice in central metropolitan Melbourne. Chris completed his BVSc at Melbourne University in 1993 followed by two years of small animal practice.

In 1995 he moved to Brisbane to work as a surgical intern at Queensland Veterinary Specialist Centre. From 1997 - 2000 Chris completed a three year formal residency training program at the University of California, Davis.

He gained Fellowship of the Australian College in 2000 and also became a Diplomate of the American College the following year. Chris started the Animal Surgery Centre in 2001 and enjoys neurosurgery, soft tissue surgery and oncologic surgery. His special interests include stifle arthroscopy, total joint arthroplasty (hip, knee, and elbow) and intraoperative fluoroscopically-guided fracture repair.

Program

SUNDAY 21 JUNE 2009

9.00 - 9.20 Understanding shoulder pathologies

What is osteochondrosis & OCD? Biceps tendonitis and the biceps test. Shoulder instability. Getting the most from shoulder x-rays. Articular steroid injections. The role of arthroscopy.

9.20 - 10.20 Elbow dysplasia and articular fractures

Pathogenesis of FMCP. Radiographic features of articular fractures, OCD, UAP and DJD. Decision making when it comes to the lame Lab puppy. Medical options. Prognosis.

10.20 -10.50 Morning Tea

10.50- 12.20 Hip dysplasia - diagnosis and treatment decision making

How early can we reliably diagnose? Stress radiographs. Symphysiodesis - how to. Which pups are TPO candidates? Is denervation something for me? Excision arthroplasty - how to get the best results. Hip replacements are available. Physiotherapy and exercises to teach clients at home.

12.20 - 1.20 Lunch

1.20 - 3.20 Cruciate ligament disease and medial patellar luxation

Patient examination techniques. Assessment of limb deformities. Understanding the plateau slope and how to measure it. How do I diagnose partial ACL tears? The principles of extracapsular techniques including the Tightrope procedure. What should I know about a TPLO? When is early surgery indicated in MPL disease? Staged or concurrent surgery? Let's talk about deepening the groove and reducing OA.

3.20 - 3.50 Afternoon Tea

3.50 - 4.30 Carpus, Tarsus and Toes

Acute vs. chronic carpal hyperextension injuries. When should I think about a carpal arthrodesis? The best x-rays to see hock OCD. Do we offer surgery for hock OCD - arthrotomy / arthrodesis? Traumatic shearing wound of the distal limb - stabilisation using frames. Sesamoiditis and arthritis of the toes - what should we try?

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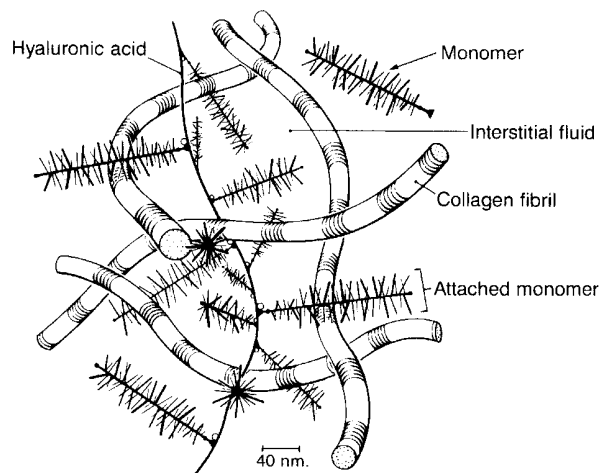
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Canine Osteoarthritis

Dr Chris Preston

Osteoarthritis is not a single disease but a syndrome characterized by pathologic change of the diarthrodial joint accompanied by clinical signs of pain and disability. 20% of adult dogs are affected.

Primary OA due to chronic “wear-and-tear” frequently occurs in the knee and hip joints in man. There is no known cause or predisposing factor in most cases and the articular degenerative changes are thought to result from high compressive loads across the major weight bearing joints over decades. In contrast, primary OA is not described in dogs. OA in small animals is always secondary to some type of trauma. This includes an abnormal force on a normal joint (eg. articular fracture with malreduction, limb deformity, joint luxation, ACL instability) or a normal force on an abnormal joint (eg. hip & elbow dysplasia, OCD, loss of joint congruency). These conditions result in poor load distribution within a joint and supraphysiologic forces to the articular cartilage which lead to mechanical failure. It is interesting to note that prolonged and vigorous use of normal joints does not result in OA. This includes increased loading such as would be the case for obese patients and amputees.



Hyaline cartilage is an avascular, aneural and alymphatic tissue found at the end of long bones. It is a smooth, resilient and wear-resistant tissue that allows nearly frictionless motion and also provides a method by which compressive load and shearing force is transmitted to subchondral bone. The extracellular matrix is composed primarily of collagen, proteoglycans and water. Chondrocytes are responsible for synthesizing and maintaining the extracellular matrix.

PATHOLOGY OF OSTEOARTHRITIS

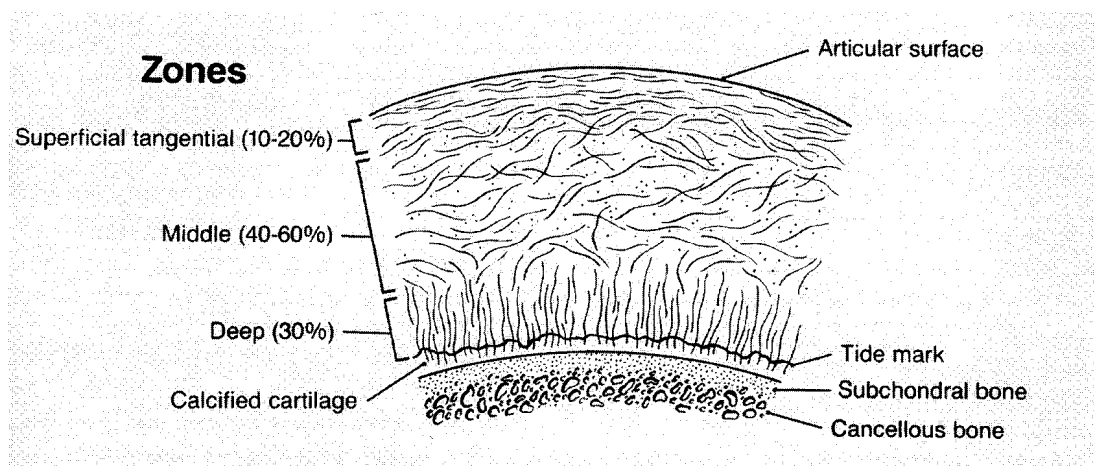
Irreversible degenerative changes associated with OA include thinning and loss of articular cartilage in areas of high stress, microfractures and remodelling of the subchondral bone plate including sclerosis and eburnation, capsular fibrosis and thickening resulting in a decreased range of joint motion, periarticular neovascularisation and infiltration of the subsynovial layer with mononuclear cells and development of marginal osteophytosis. The early phase of cartilage degeneration, which can be first appreciated arthroscopically, is roughening or fibrillation of the superficial cartilage layers. This is followed by the development of deeper erosive lesions and chondromalacia. Finally, full-thickness cartilage is lost exposing the underlying subchondral bone plate.

Osteophytes are frequently associated with the development of OA. They are composed of a central core of bone that blends in with the subchondral bone, are covered by hyaline and fibrocartilage, and are formed by a process similar to endochondral ossification. Osteophytes tend to occur at the joint periphery, most frequently at the junction of the synovium, perichondrium and periosteum, although they may occur centrally in the joint.



PATHOPHYSIOLOGY OF OSTEOARTHRITIS

The interaction of collagen, proteoglycans and water is integral to the maintenance of articular cartilage. The turgidity of articular cartilage is maintained by the interaction of the osmotic swelling pressure generated by proteoglycans and water as well as the restraint to swelling provided by the collagen network. Disruption of the collagen fibrils due to mechanical or chemical insult diminishes intrinsic tensile stiffness of articular cartilage, and loss or alteration of proteoglycan content reduces compressive stiffness. Water content of cartilage increases with collagen disruption, leading to cartilage swelling. Changes in the material properties lead to compromise of the lubricating and load-carrying capacity of articular cartilage. These changes tend to be progressive and correlate with the degree of degeneration present.

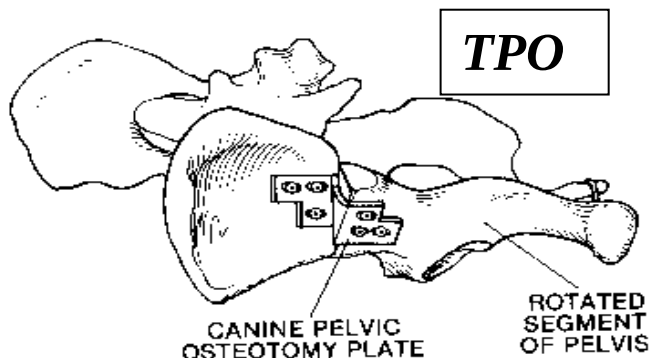
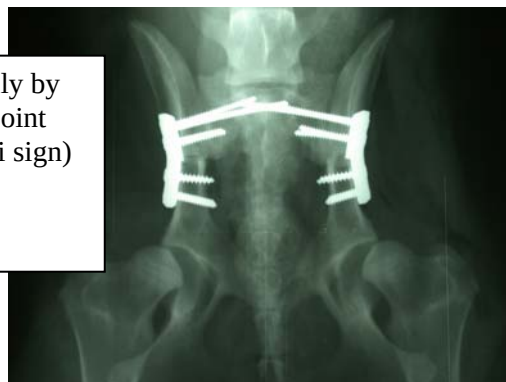


MEDICAL MANAGEMENT OF OA

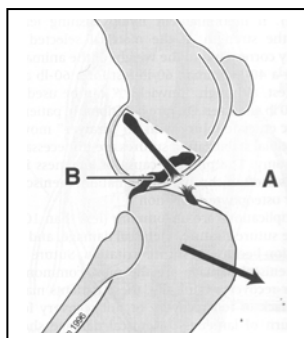
Conservative therapy consisting of dietary modification (omega 3 & 6 FAs), exercise moderation (low impact activity), physical therapy and medical management, should always be considered as an alternative to surgical therapy or as temporary treatment prior to definitive surgical intervention. Currently, NSAIDs (eg. meloxicam, carprofen) are popular due to their relatively high response rates and acceptable safety margin when used long term. Chondroprotective agents (eg. cartrophenR) as well as slow-acting disease-modifying drugs (eg. glucosamine & chondroitin supplements) can be used also to slow the rate of joint degradation. Clinicians should consider the following factors when making treatment recommendations to clients with pets suffering from OA: patient size, age, weight, general health, severity of disability & intended use of patient; the availability, success rate, potential complications & costs of surgical options; and the goals, compliance & financial constraints of the owner.

CORRECTIVE OSTEOTOMIES

Hip dysplasia is common and can be managed surgically by performing early corrective surgery. Dogs must show joint pain / disability, have palpable laxity (positive Ortolani sign) and have no evidence of degenerative changes to be acceptable candidates for TPO surgery.

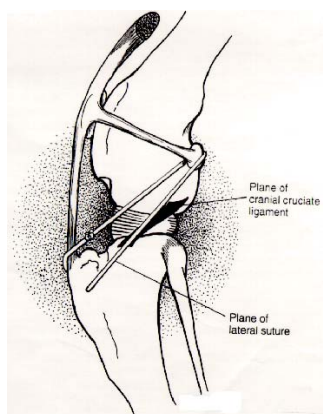


Concurrent bilateral TPO surgery is a viable treatment option with relative advantages over staged surgeries including early intervention bilaterally, a shorter recovery period and lower overall costs



TPLO

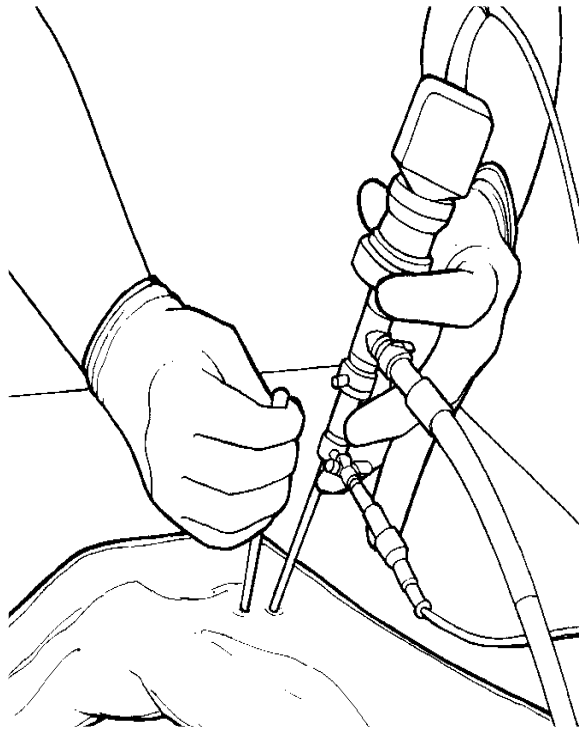
In my opinion, clinicians should be familiar with extracapsular procedures as well as tibial corrective osteotomies as different styles of surgery to address cruciate ligament disease. There is no problem performing a DeAngelis style of surgery and many dogs recover and function well. The TPLO tends to achieve more consistent results in larger patients and importantly can limit progression of a partial tear.



ARTHROSCOPY

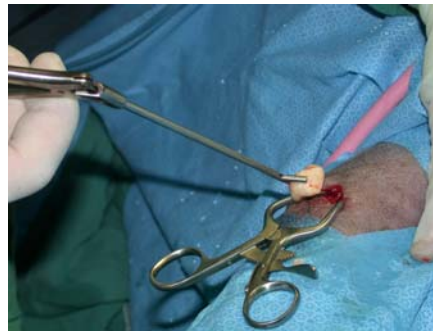
In human orthopaedics, arthroscopic treatment of OA includes lavage, debridement of damaged tissues, synovectomy, bursectomy, lysis of adhesions, stabilization procedures, releasing procedures and arthroplasties. Arthroscopy has replaced open joint surgery in the diagnosis and treatment of many joint conditions in both human and veterinary medicine such as OCD lesions and meniscal tears. Evaluation of articular structures is improved with magnification and illumination. Arthroscopic surgery offers the relative advantage of lower morbidity in terms of postoperative pain, incidence of infection and risk of wound healing complications when compared to an arthrotomy. Relative disadvantages include the technical resulting in a steep learning curve and the relatively high equipment costs.

‘scope’





Partial cruciate rupture



OCD flap from shoulder



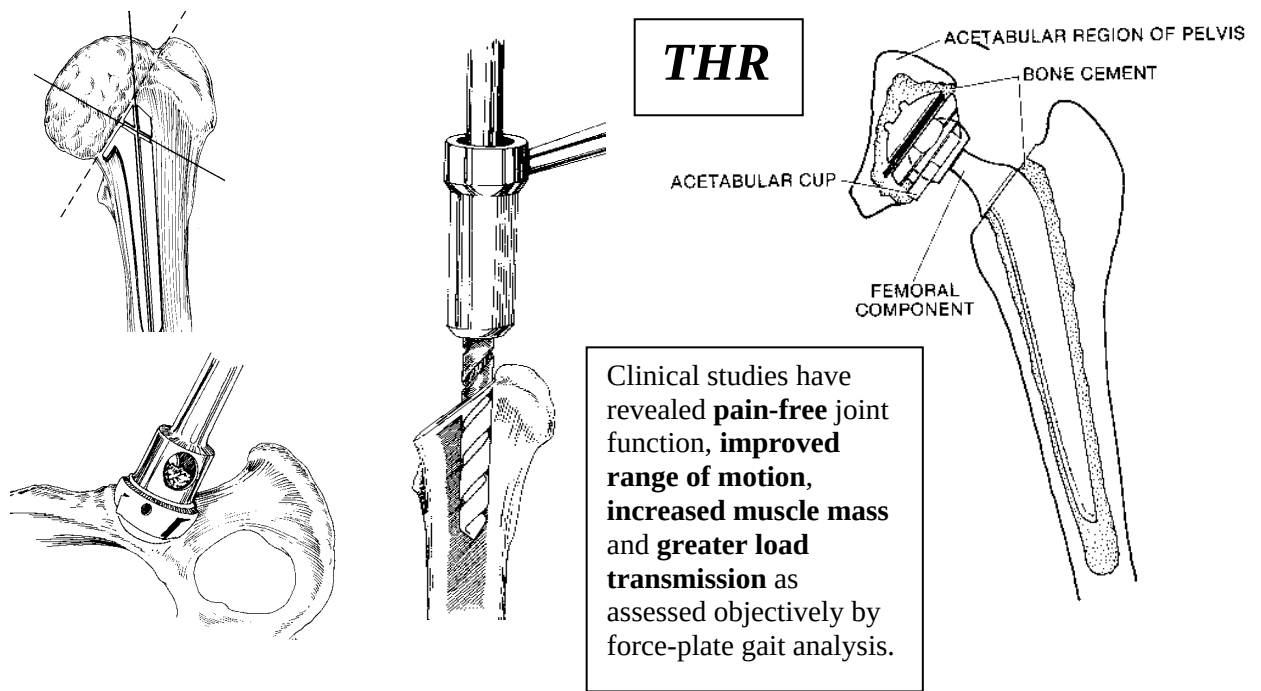
Medial meniscal tear

Common applications reported in the vet orthopaedic literature include:

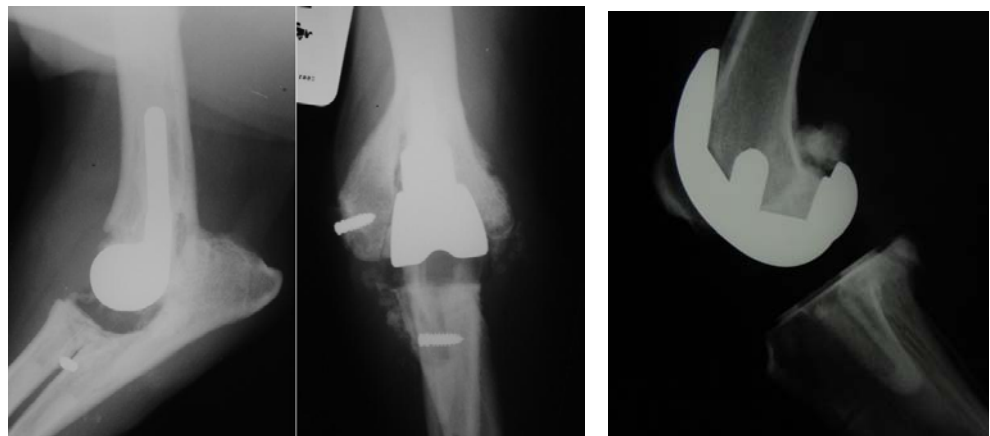
- Treatment of **elbow dysplasia** (removal of FCP & abrasion arthroplasty)
- Diagnosis of **partial anterior cruciate ligament** rupture
- **Meniscectomy** following successful extracapsular (ie. DeAngelis) surgery
- Retrieval of **OCD** flaps (shoulder, elbow, stifle & hock)
- Diagnosis & treatment of **bicipital tenosynovitis** of the shoulder

ARTHROPLASTY

THR is indicated in patients with medically-unresponsive, non-infectious, non-neoplastic, disabling conditions of the coxofemoral joint. The most common indication is osteoarthritis secondary to canine hip dysplasia however THR can also be appropriate in other cases such as coxofemoral luxation (chronic traumatic or non-traumatic), femoral head disease such as non-reconstructable fracture or avascular necrosis, nonunion or malunion of femoral neck and acetabular fractures and failed excision arthroplasties. The clinical signs of hip pain can initially be as subtle as: stiffness in the morning, slowness to get up, not wanting to exercise as long or as vigorously, a change in stride of the hind legs, “bunny hopping”, wanting to sit down while eating and during walks or reluctance to stand.



Elbow and Knee replacement surgery is now available in Australia and offers durable function for dogs with end-stage osteoarthritis. These systems have cemented and cementless fixation options but have a metal-on- plastic bearing surface.



TER

TKR

ORTHOPAEDIC EXAMINATION

Performing a thorough patient examination in a lame dog is a skill which will allow accurate diagnosis and lead you on to further diagnostics such as plain film radiography. There are general principles and there is experience and 'pattern' recognition. It is critical to determine the broad categories first such as appendicular orthopaedic disease versus neurological / spinal disease. As I often explain during my initial consultation with the client - 'If you start barking up the wrong tree you will never get there', simply meaning that knowing the pet has ataxia rather than stiffness means you have a chance at attaining the correct diagnosis. Always keep in mind that it is OK to say that you do not know why the animal has ambulatory difficulty. Also try not to make something up to appease the clients – you never know what they will end up doing with their pets and you could get into muddy waters. Do not let the client tell you which limb is sore or which area of the body is causing the problem. It is easy to be nice and agree with their diagnosis!

Step 1: Standing conformation

There is a lot of information to be gained observing the limbs, foot position and weight distribution. Some patients will be non weight-bearing, others will lean off the limb and toe-touch. Look for limb deformities such as carpal valgus or hyperextension, hock hyperextension etc... Marked muscle atrophy can usually be appreciated visually unless the haircoat is long. If your patient has bilateral pelvic limb pain, there may be a generalized weight shift onto the thoracic limbs and muscle hypertrophy. Conversely, forelimb pain can result in a weight shift onto the pelvic limbs.

Step 2: Gait assessment

Take the dog outside. Provide clear instructions to the owner as to what and how you would like to dog walked. Ask them to speed up or slow down. They are paying you to get the most out of the consultation – they do not get aggravated if the vet instructs them on how to walk their pet. Often dogs are relaxed when walking and you can get an idea of what the diagnosis is even before you touch the limbs. Ask yourself “ is the limb and foot placement appropriate ?“. Patients with neurological disease will often have subtle proprioceptive deficits and inappropriate foot position / placement. Look for head bobbing to confirm the side on a forelimb lameness. Look for rising and falling of the pelvis for hindlimb lameness.

Step 3: Orthopaedic examination

- Muscle mass – atrophy, hypertrophy
- Range of motion
- Discomfort / pain
- Longbone shaft pain
- Swelling / effusion
- Periarticular fibrosis
- Instability – hip, knee



NOTES:

Understanding Shoulder Pathologies

Dr Chris Preston

Osteochondrosis / OCD is a common heritable developmental disease which can affect the shoulder, elbow, knee and tarsus. Many affected dogs are large, fast growing, male and of the popular breeds (Labrador, GR etc). Bilateral joint involvement is common. The pathophysiology involves focal disruption of the normal maturation process whereby cartilage on the joint surface becomes bone. This represents a derangement of endochondral ossification with the production of thick areas of articular cartilage. The deeper chondrocytes undergo necrosis due to insufficient nutrition and can no longer synthesize and maintain the cartilage matrix. Typically osteochondrosis is clinically silent and predisposes dogs to the development of OCD, whereby the thickened region of cartilage loses its underlying attachment to the subchondral bone and forms a loose flap. Pain results from inflammatory joint mediators causing synovitis and pressure on exposed bone from the mobile cartilage flap.



Most flaps will spontaneously dislodge and the patient may improve. There is a risk that the flap will migrate into the bicipital

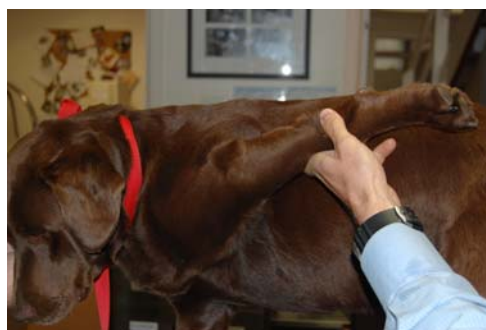
groove area and impinge on the biceps tendon or that the inflammation will result in long-term osteoarthritis. Early arthroscopic retrieval of the OCD flap offers an excellent prognosis.



BICEPS TENOSYNOVITIS

Biceps tendon pain tends to develop in active farm dogs and affects only one leg. Clinically, there may be discomfort during shoulder manipulation or there may be pain when direct pressure is placed over the tendon of origin of the biceps brachii muscle when the shoulder is held in flexion and the elbow in extension. The cause of this condition is largely unknown but can involve chronic overloading associated with high levels of activity.

Treatment involves rest, articular steroids and possibly tendon transaction (tenodesis). Typically, plain shoulder radiographs are unrewarding and arthroscopic assessment is required to achieve a diagnosis. Ultrasound has been described to assess the bursa surrounding the biceps tendon.





SHOULDER INSTABILITY

Medial capsular ligamentous insufficiency likely due to chronic repetitive mechanical overload can result in a loose shoulder. These joints have medial laxity compared to the normal contralateral side. Diagnosis is difficult without arthroscopy as the examination findings and radiographic features are subtle. Capsular shrinkage using radiofrequency energy has been described and offers excellent results.



RADIOGRAPHY OF THE GLENOHUMERAL JOINT

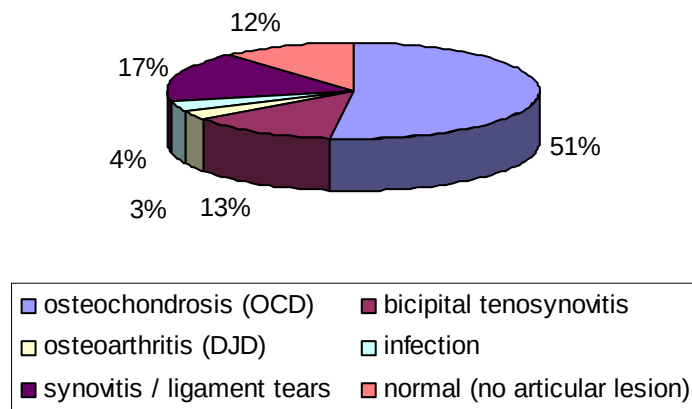
A lateral shoulder radiograph should be taken by pulling the affected limb away from the body and having the head and neck extended. This will avoid having the sternum superimposed on the region of interest. You can assess the glenoid for evidence of marginal osteophytes on the caudal rim and the humeral head for flattening (OCD) and osteophytes on the caudal aspect of the articular surface. Changes within the bicipital groove, such as sclerosis and irregular new bone production, are suggestive of clinical biceps tendon disease. The A-P or P-A view is not often helpful and assessment of subluxation or laxity is difficult.



SHOULDER ARTHROSCOPY

I have been involved with shoulder and elbow arthroscopy since 1998 and have found it superior to open arthrotomy in regards to visualization, postoperative complications, client acceptance and speed. The majority of forelimb lameness cases that are managed arthroscopically are discharged that same afternoon as day cases. This is practical and well received by clients. There is an associated learning curve, not only with the use of instruments and the development of triangulation skills but also in gaining familiarity with normal and abnormal joints. The elbow is certainly the place to start when learning. Establishment of shoulder portals is more challenging.

Distribution of 102 canine shoulder arthroscopy cases over a five year period [ASC 4/02-4/07]



Arthroscopic evaluation of the glenohumeral joint can be performed through a subacromial portal which allows thorough assessment of the entire joint. This is my default portal for exploration of painful shoulders, biceps cases as well as those with known OCD lesions.

Traditionally, patients are operated in lateral recumbency and an assistant holds the distal extremity to apply controlled traction and achieve a degree of joint distraction. I have used a wide strap to hold the thoracic cage to the patient table and have found this far better than simply having the assistant pull on the leg. The strap is placed under the chest and on both sides with the limbs of the strap dorsal to the patient's thoracic spine. These two ends of the strap are then secured to the side of the operating table where the arthroscopic tower will be positioned. The surgeon stands on the 'foot' side of the table with the assistant either on the left or right; whichever is more comfortable. The assistant is responsible for flexion, extension, traction, abduction and adduction.

A more recently described technique involves a hanging-limb style of setup with the patient positioned in dorsal recumbency. The foot is connected to the ceiling and the patient table lowered to use the patient's bodyweight to achieve distraction of the joint. I have used this approach and found it to be somewhat disorientating as the shoulder joint is upside-down. The distinct advantage of this technique is that a cranial and /or medial portal can be established as with human arthroscopy of the glenohumeral joint. This allows easy access to a craniomedial portal (between the biceps tendon

and serratus ventralis). The patient must be positioned with the shoulders at the end of the table and with the head and neck reflected ventrolaterally, otherwise the surgeon will not be able to stand anterior to the shoulder joint.



I use a manual fluid management system which relies on gravity flow through large diameter tubing rather than a mechanized fluid pump. There is a collapsible chamber that the assistant can compress to pressurize the system and this is typically performed when there is bleeding evident arthroscopically.

I typically inject up to 10 mls of saline through a 22 gauge hypodermic needle and keep that needle in position whilst the arthroscopic portal is created. I have had problems establishing this portal if the needle is extracted and a scalpel blade used 'blindly'. I have developed a technique where the needle acts as a direct guide to the joint position and I prefer to use a number 11 blade to cut directly in line with the needle that enters the joint.

For dogs up to 25-30 kgs, I use a 2.7mm arthroscope and for larger dogs a 4.0mm arthroscope. I have used a 2.4mm arthroscope in very small patients. I strongly feel that use of the 4.0mm scope provides a significantly larger image and makes triangulation easier due to a larger field of view. I do not feel that there is significantly higher morbidity associated with the use of the larger arthroscope and sheath in most of the OCD cases. I feel that establishment of shoulder portals is somewhat difficult and that generally a larger initial scalpel blade incision allows far easier placement of a blunt trocar and sheath.

I routinely explore the entire joint which includes assessment of:

1. humeral articular surface
2. glenoid articular surface
3. synovium
4. bicipital tendon
5. medial glenohumeral ligament

The most common diagnoses in my hospital caseload are:

1. osteochondrosis / OCD
2. bicipital tenosynovitis
3. synovitis of unknown origin



Most OCD lesions involve a solitary, well defined cartilage flap lesion that can be easily extracted using grasping forceps through a caudal arthroscopic portal. This portal can be challenging to establish due to the deep location of the humeral head medial to the triceps musculature. I prefer to place a spinal needle (2-3 inches long) into the caudal aspect of the joint whilst looking for the needle trocar arthroscopically. The needle needs to enter the skin

surface caudal and ventral to the subacromial arthroscopic portal. It is ideal to have the needle placed divergent to the line of the arthroscope. Once the tip of the needle has been visualized, the surgeon should assess its proximity to the OCD lesion when the needle is not being manipulated. It is better to reposition the needle and achieve a more accurate needle placement than to establish a portal that is poorly directed relative to the region of interest. Once the needle placement has been optimized, a large access incision is made to allow extraction of the flap in one piece. A system of cannulas can be used to maintain the caudal instrument and allow easier introduction of hand instruments.



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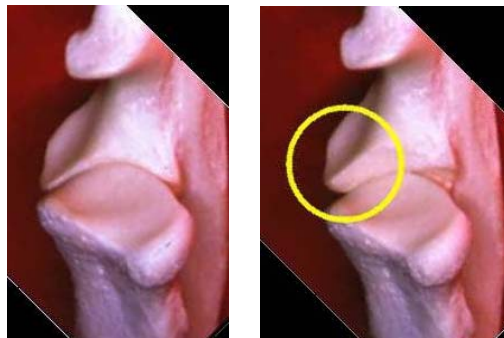
Elbow Dysplasia

Dr Chris Preston

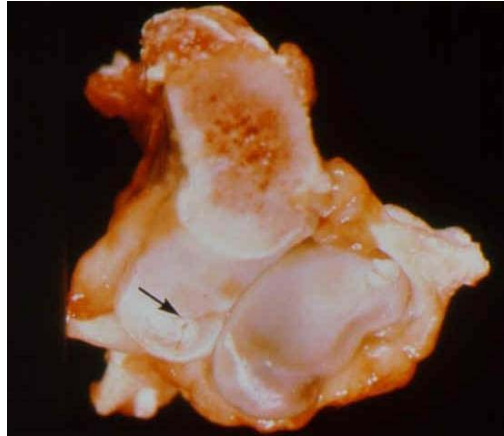
There is a common misconception that osteochondrosis is the same thing as elbow dysplasia (ED). Indeed this was the dogma for many years until further work showed that fragmentation of the medial coronoid process of the ulna (FMCP), the most common style of ED, involves subchondral bone pathology with normal hyaline articular cartilage on the surface. Thus the first thing to say is that OCD is not ED, but one individual entity under the umbrella term of ED.

ED is best thought of as a syndrome with three separate diseases: OCD, FMCP and UAP. The specific cause of each condition remains unknown. In many dogs, two of three conditions can occur within one joint. For example, 50% of dogs affected with ununited anconeal process (UAP) have FMCP in the same joint.

It is now well accepted that FMCP develops in joints with mild articular incongruity whereby the radial articular surface is recessed relative to the distal aspect of the trochlea notch of the proximal ulna. This creates a step between the radial head and lateral edge of the medial coronoid process. *In vitro* models simulating this situation have supported this theory.



Electronmicroscopic studies of retrieved bone and cartilage fragments from clinical cases have shown that the bone undergoes progressive microfracture and fissures develop in the subchondral bone that eventually extend to the articular surface (*in situ* FMCP). Once the cartilage fractures along these cleavage lines the fragment becomes a displaced FCP.



Concave incongruity refers to a difference in the radius of curvature of two interacting joint surfaces. If the radius of the humeral trochlea is larger than that of the combined articular surface of the trochlear notch of the ulna and radial head, then the contact areas will be peripheral. This results in supraphysiologic forces between the humeral condyle and anconeal process and may contribute to the development of UAP lesions as well as subchondral sclerosis of the distal trochlea notch of the ulna as seen in this clinical case.



RADIOGRAPHY OF THE JUVENILE ELBOW

Traditionally assessment of the cubital joint involves an A-P and M-L views as well as a flexed M-L view to look at the anconeal process of the ulna.

Osteophyte formation involving the: caudal aspect of the anconeal process, radial head and caudal distal ulna are the most consistent areas to look for early degenerative changes which would suggest the presence of ED. Sclerosis of the subchondral bone of the distal aspect of the semilunar notch of the ulna can develop also.

Although OCD (focal concavity medial humeral condyle) and UAP (persistent physeal line) can be definitively diagnosed with plain film radiography, FMCP, the most common form of ED, cannot. The fragments are small, minimally-displaced and rarely seen on x-ray. CT scans are required.

Step incongruity can be diagnosed radiographically and is often secondary to premature distal ulnar or radial physeal closure. Radiographic studies have shown, however, that the sensitivity of radiography to detect subtle (<4mm) step defects is low and clinicians should understand this limitation.

Panosteitis is a painful, temporary condition seen in GSDs whereby they develop painful longbones. Multiple limbs can be affected. Radiographic features include diaphyseal intramedullary radio-opacities most common in the distal humerus, proximal radius and proximal ulna.

Incomplete ossification of the humeral condyle has been reported in Spaniel type breeds as a congenital weakness which predisposes to fracture of the distal humerus under physiologic conditions (ie. pathological fracture).





Surgical repair of IOHC



HOW TO HANDLE THE LABRADOR PUP WITH FORELIMB LAMENESS

Confident diagnosis and successful treatment of chronic forelimb lameness cases is challenging. If we have a 6-12 month old Labrador pup with a chronic, intermittent, medically-unresolved, unilateral forelimb lameness and normal elbow radiographs, it can be frustrating to offer anything to the owners. This situation is common in small animal vet practice.

CT scanning is widely available and allows 3-D imaging. It will help clarify if the coronoid region is involved, identify incomplete ossification of the humeral condyle and may aid in looking for step incongruity.

Medical options include strategic use of NSAIDs, a course of chondroprotective agents (eg. cartrophen series of injections) and oral dietary supplementation with chondroitin and glucosamine. More recently, Omega -3 fatty acid supplementation has shown efficacy (eg. Hils J/D).



Arthroscopy has been a well accepted in the veterinary profession for the management of ED as a practical treatment option for many clients and allows a single-stage diagnosis and treatment in the vast majority of dogs with convincing elbow pain on physical examination. Patients are treated the same day as the consultation and are able to walk home that afternoon. There is minimal pain and associated wound morbidity. Client acceptance is high. Showing the pet owner a video of their dog's articular pathology is invaluable in explaining why many dogs will not improve long-term.

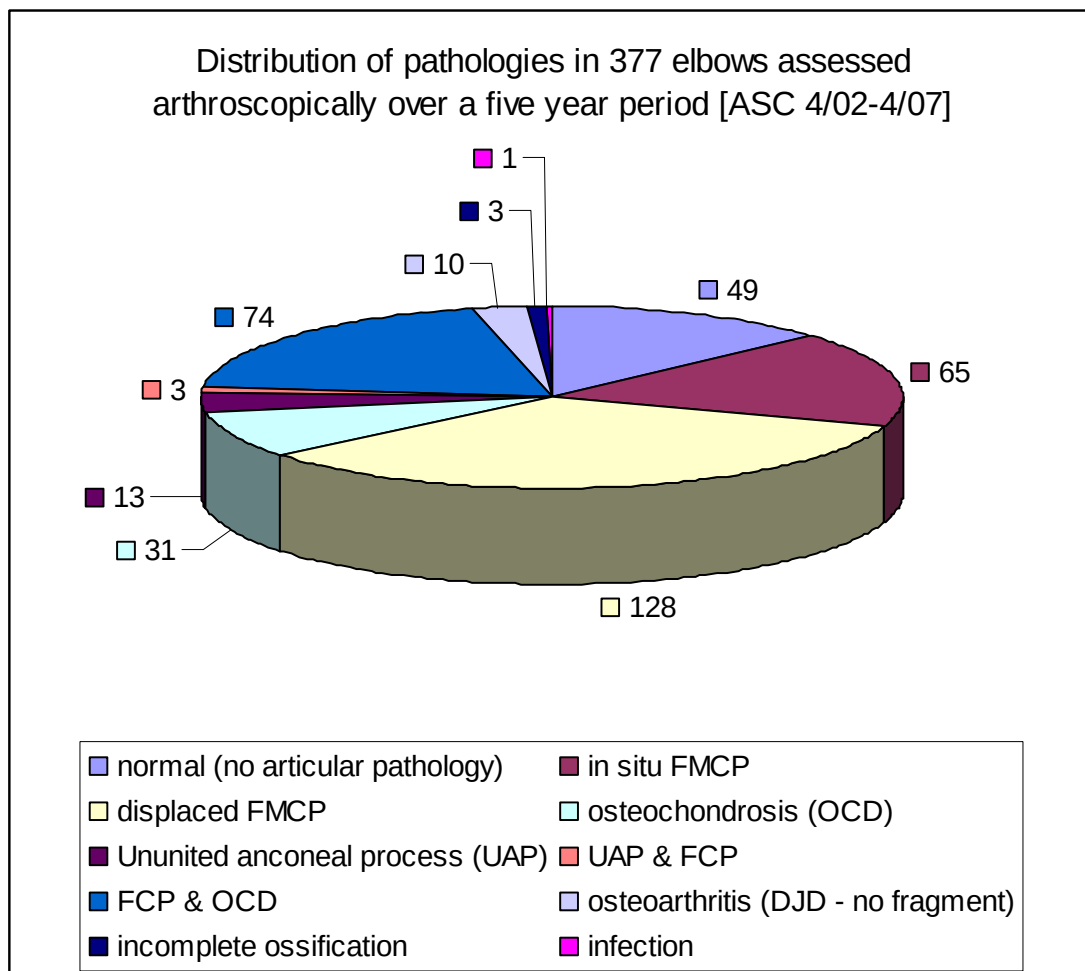


Medial elbow arthroscopy can be performed with the patient in either lateral or dorsal recumbency. I have used both positions over the years and prefer patients to be positioned in lateral recumbency. I use a wooden block as a fulcrum to improve valgus stress on the elbow. The scrubbed assistant is instructed to extend, pronate and apply a valgus stress in order to improve access to the medial coronoid region of the ulna.

I use either a 2.7mm or 4.0mm arthroscope in most elbows. I feel that in joints with effusion and more pain, I can generally upsize the arthroscope size and gain improved visualization. I use a manual fluid management system which seems to work fine. Following fluid insufflation, I attempt to palpate the MCL and create a caudomedial arthroscopic portal and a craniomedial instrument portal. I do not use cannulated instrument portals.

I recognize a spectrum of FMCP pathology starting with minor cartilage fissuring and a so-called *in situ* FCP and progressing through to a displaced osteochondral fragment. I attempt to describe the degree of opposing humeral cartilage pathology as normal, mild, moderate or severe as well as comment on the degree of synovitis. I use hand curettes to debride *in situ* lesions and small

joint grasping forceps to retrieve loose osteochondral fragments. Distal humeral OCD flaps are extracted using the same hand instruments. Subtotal coronoidectomy can be performed arthroscopically using a small chisel. This is gaining popularity in elbows with necrotic MCPs.

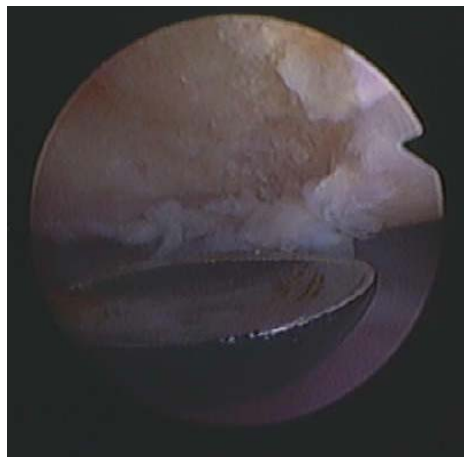


A recent retrospective study in Germany described the long-term outcome of 450 canine patients after either open surgical debridement or after arthroscopic debridement of fragmented medial coronoid processes. A variety of lesions were observed including cartilage fibrillation, chondromalacia, *in situ* and free osteochondral fragments and the so-called "kissing" lesions on the humeral condyle opposite the medial coronoid process.



Fragmented coronoid

All patients presented for uni- or bilateral thoracic limb lameness and had elbow radiographs that revealed early radiographic changes consistent with elbow dysplasia.



Follow-up periods ranged from 6 months to 3 years and consisted of radiographic evaluation and veterinary examination. The authors of the publication concluded that approximately 90% of the patients had good to excellent limb use. In my experience elbow arthroscopy is less traumatic and allows more thorough removal of loose bodies compared to open joint surgery. This particular study revealed that the time to maximal improvement was halved by using arthroscopic techniques (4 weeks vs. 8 weeks).

Concurrent ulnar shortening procedures are popular and support the theory of primary articular 'step' incongruity between the medial aspect of the radial head and the lateral aspect of the medial coronoid process of the ulna. There is no consensus or even quality research to support regular application of such procedures. I only offer distal segmental ulnar ostectomies if gross incongruity is evident radiographically.



SLIDING HUMERAL OSTEOTOMY

Developed at the University of California, this seemingly risky procedure has been performed in over 70 Labradors with encouraging early results. The concept is to take young dogs with ED and medial compartment disease (full-thickness cartilage loss) and transfer the compressive loading forces laterally onto the more normal lateral compartment. This is achieved by performing a transverse diaphyseal osteotomy that is translated 10mm and stabilized using a custom 3.5mm broad step plate. The axial compressive loads tend to shift laterally and are transferred through the radial head and lateral aspect of the humeral condyle.

The arthroscopic images from a young Labrador show the improvement 6 months postoperatively. Client satisfaction has been high so far.

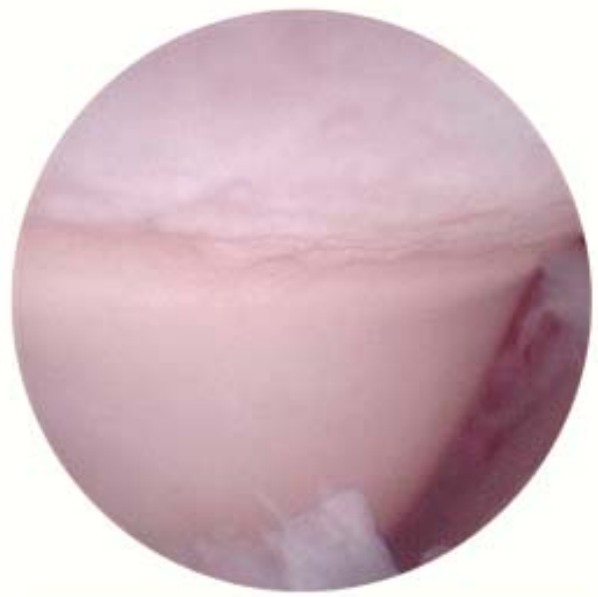


Postoperative SHO

Healed SHO



Medial elbow joint before SHO



Medial elbow joint 6 months after SHO

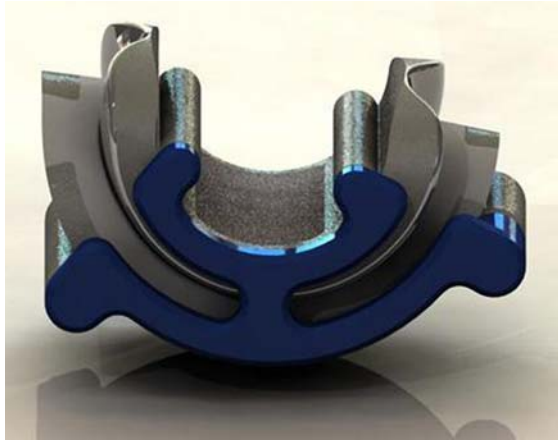
Sliding humeral osteotomy (SHO) is not indicated if extensive osteoarthritis is present and there is involvement of the lateral joint compartment. Total joint replacement would be a more suitable procedure in that situation. SHO is available at the ASC.

CEMENTLESS TOTAL ELBOW REPLACEMENT

In 2008 the new minimally-invasive cementless elbow replacement system was introduced to allow severely affected dogs to improve after surgery. The technique has been refined to allow a relatively low morbidity medial epicondylar osteotomy. This preserves collateral ligament integrity and allows immediate postoperative elbow stability to be maintained. The two components are inserted simultaneously as a so-called cartridge implant. Both components are cementless with porous coatings which allow bone ingrowth and osseointegration for quality long-term fixation.

The blue connector links the two components and is used to allow precise implantation of the pair of implants simultaneously. The radioulnar component has a polyethylene liner which creates a metal-on-plastic system. As of mid-2008, approximately 45 dogs have been implanted with only one major complication. This system is available at the ASC.





Humeral Component



Radioulnar Component

NOTES:

NOTES:

Hip Dysplasia

Dr Chris Preston

Hip dysplasia is an extremely common presentation to veterinarians, especially in large breed dogs. While medical management with pain killers, chondroprotectives and weight loss is an option in some cases, a range of surgical procedures can be highly successful and provide long term effective management of the disease.



PUBIC SYMPHYSIODESIS

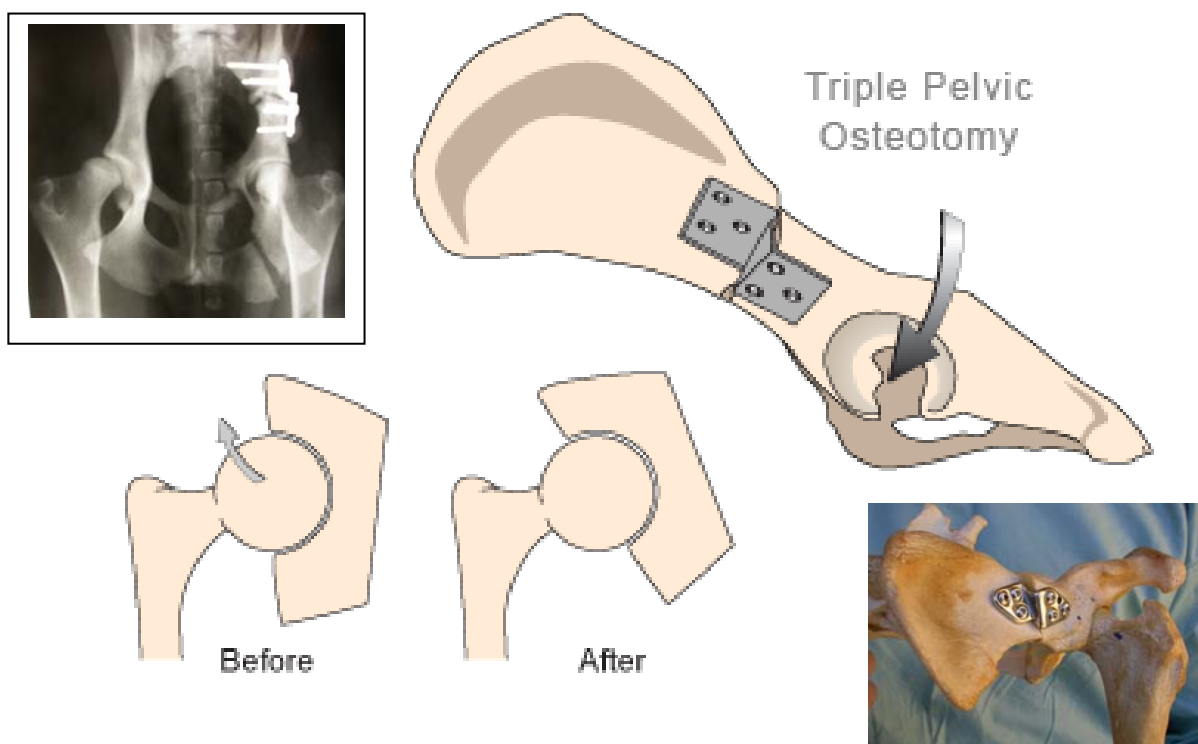
JPS (Juvenile Pubic Symphysiodesis) is an exciting new procedure for very young puppies (less than 18-20 weeks of age) which are detected with CHD by hip palpation (Ortolani test) and PennHIP distraction radiographs. In this surgery, the pubis is surgically fused resulting in rotation of the acetabulum around the femoral head as the dog matures. Early results are very encouraging. JPS is a prophylactic procedure.



Many practitioners routinely palpate hips in predisposed breeds at the time of elective desexing. If they feel mediolateral hip laxity, distraction view radiographs can be performed to quantify laxity. JPS is an easy and relatively low risk procedure that offers bilateral improvement in hip congruency and biomechanics. Electrosurgery is used to achieve thermal chondrocyte necrosis and prematurely close the physis of the pelvic floor.



TRIPLE PELVIC OSTEOTOMY



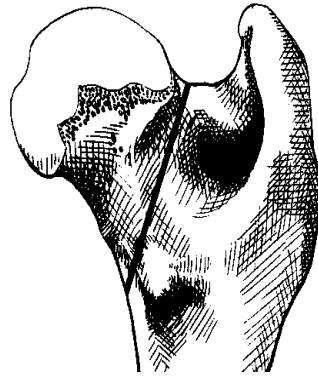
Selection of pups for TPO surgery requires accuracy and consideration of factors such as pain & disability, mediolateral hip laxity and evidence of radiographic degenerative changes. It is important to accept the limitations of this procedure in that it cannot stop the progression of osteoarthritis once established. Strict adherence to selection criteria is paramount to achieving long-term arthritis-free hips. It also needs to be accepted that there is now less pressure on accepting borderline candidates for TPO given the major improvements on THR options for young dogs (ie. the availability of cementless components and systems). TPO is a robust and proven procedure.



A special radiographic view can be taken to specifically assess the integrity of the dorsal acetabular rim (DAR view) as shown above. The normal dog on the left has congruent hips and sharp, triangular shaped central acetabular rims. If this dog has lameness / stiffness, hip pain and positive Ortolani's tests, TPO surgery would be an accepted treatment. The DAR view on the right shows significant erosion of the acetabular rim due to ongoing hip instability. This patient would be declined as a TPO candidate at the ASC and an alternative procedure discussed.

EXCISION ARTHROPLASTY

Excision arthroplasty is a salvage procedure aimed at providing pain-free function by removing the offending articulation and allowing function through the formation of a fibrous pseudoarthrosis. The technique has successfully been performed in the glenohumeral, coxofemoral and temporomandibular joints. Pain is relieved by elimination of bony contact as scar tissue fills the "joint" space after surgery. Femoral head and neck excision can be a successful treatment for coxofemoral OA with best results in smaller patients.



Complete excision of the femoral head and neck is vital to success. Interpositional muscle flaps, using the gluteal and vastus lateralis muscles, have been studied and provide no additional benefit. Performing this technique prior to severe disuse muscle atrophy is recommended. Slight limb shortening results and the false joints have a reduced range of motion. Outcome is dependent on preoperative muscle mass and early postoperative physical therapy. Preserving and promoting muscle mass and range of motion in the joint through early (3-5 days) postoperative ambulation and passive range-of-motion exercises will maximize joint and limb function.



Indications for excision arthroplasty include vascular necrosis, severe CHD, non-reconstructable acetabular fractures and chronic coxofemoral luxation. Often FNHE is the only option if clients cannot afford THR. Legg-Perthes typically involves one limb only and histologically involves ischaemic necrosis of the subchondral bone of the femoral head. Loss of support of the underlying trabecular bone develops and a loss of normal femoral head and neck geometry follows due to mechanical collapse. Male Terrier

breeds are over-represented. Serial V-D hip-extended pelvic radiographs are useful to document progressive deformation. Secondary osteoarthritis will develop.



HIP REPLACEMENT

THR involves the complete reconstruction of the coxofemoral joint, by replacing the diseased eburnated cartilage and degenerative bone with prostheses. This is a major procedure with excellent predictable results achieved by experienced surgeons. A range of prostheses are available for dogs with differing sizes and modularity. Here we see a mini-implant suitable for Toy breed dogs.



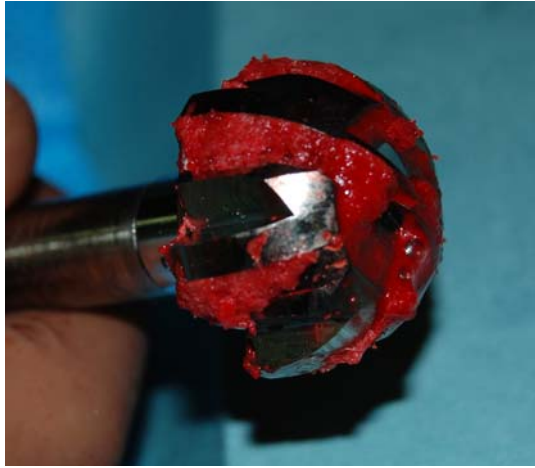
The market leader in total hip replacement prostheses is an American company called Biomedtrix. They produce a cemented arthroplasty and a press fit ingrowth cementless hip. Other smaller less used companies are also available in Europe. These systems are less popular and have been associated with complications such as femoral fracture and luxation.

Since Charnley first developed the cemented total hip replacement in people more than 40 years ago, refinement of the materials and cements have occurred. The Biomedtrix implants are machined and worked to the same stringent requirements of human prostheses. It is essential the materials are processed and sterilized under strict conditions to protect the implants for life.



The Biomedtrix CFX cemented fixation THR is the most tested, trialled, developed and used THR for dogs in the world. Many dogs presenting for THR even from young ages will have dramatic reductions or absence of cartilage in the joint.

The acetabular cartilage and bone is reamed away using specialized acetabular reamers.



An ultra-high molecular weight polyethylene prosthetic cup is placed into the resultant acetabular bed. This is secured with medical grade polymethylmethacrylate or bone cement. The bone cement acts as a grout rather than a glue and must be shelved into the acetabular and ilial bone. Orientation and positioning are important in order to provide passive capture of the femoral head. Like human THRs, the canine versions are non-restraining systems. There is no prosthetic attachment between the femoral head and acetabulum. The design of the system and the repaired joint capsule provide stabilisation of the system.



A femoral neck osteotomy which differs in slope and position from a femoral head and neck ostectomy is performed and the proximal femoral medullary canal is opened and reamed. An area of medullary but not cortical bone is removed to allow seating of a cobalt chromium femoral stem, as well as a mantle of bone cement around the prosthesis.

Cemented THR is designed to last the life of the dog, and in most cases this is achieved. Surgical experience is a key determinant to successful implantation and minimization of complications. It is essential the surgeon is trained in a formal residency situation and performs a high volume of procedures to work through the steep learning curve associated with hip replacement. It may take at least 50 to 80 procedures for a surgeon to become familiar enough with the procedure to be safe and competent in the surgery.

Results with cemented THR have been presented by Olmstead from Ohio State University and a success rate well above 90 per cent can be achieved. Dogs can be improved dramatically from a situation of lameness and pain, to athletic performance and a pain free existence.



Biomedtrix Cementless Total Hip Replacement has now been available since 2003. This system is an ingrowth press fit system. Initially it relies on the precise removal of bone from the acetabulum and the femoral medullary canal, and the very tight frictional fit of the implant. With time, unlike any of the other cementless systems on the market, cancellous bone grows into the porous surface of the implant. This system was based on the North Carolina State Howmedica PCA (Porous Coated Anatomic) total hip which has been available on a very limited basis non-commercially since the early 1990's. Results of long term analysis of the PCA have been excellent.

The cementless system is especially useful in the management of young large breed dogs who have the best opportunity for bone ingrowth and long term success with the THR.



PHYSIOTHERAPY & HOME EXERCISES

I believe that the client compliance with home exercises is poor, even following demonstration of exercises and provision of detailed written material. Typically, the thought of inducing pain and having their own pet vocalize and struggle, is enough to stop most owners from making progress.

There are activities which can help and are practical. Swimming and other forms of hydrotherapy are weather dependent and somewhat uncontrolled, but do encourage range of motion without impactful skeletal loading. Holding the forelimbs off the ground (dancing) is easy and encourages standing on the affected pelvic limb with the coxofemoral joint extended. Lifting one normal (non-operated) limb off the ground can help teach proprioception and may aid earlier return to toe-touching.



NOTES:

Cruciate Disease in Dogs: Improving Your Skills in Diagnosis and Treatment

Dr Chris Preston

PATIENT EXAMINATION TECHNIQUES

Following a thorough general physical examination, assessment of the lame dog involves three sequential steps. The way a dog stands can be of great benefit in helping establish a short list of differential diagnoses. Assessment of standing conformation involves looking for weight shifts, evidence of muscle atrophy and looking at the standing angle of joints. Visual evaluation of gait can be challenging in companion animal practice as few owners are able to suitably control their pets. Typically the patient is walked then trotted outside and the trunk, head and limb movements observed. Finally a complete orthopaedic examination is performed with the patient adequately restrained.

Muscle atrophy



Weight shift – ‘toeing off’



Medial periarticular fibrosis



Incomplete stifle extension



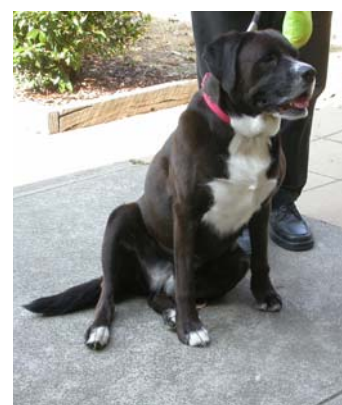
Hock hyperextension



Tibial subluxation



Positive 'sit test'



Limb malalignment (genu varus / tibial torsion)



Tibial compression test



Palpation of the knee is used to achieve a diagnosis in most patients. You can assess pain, range of motion, crepitus (DJD), clicking (meniscal tear) and craniocaudal instability (drawer motion). It is wise to assess medial (and lateral) patellar movement as some dogs have both ACL disease and patellar instability. It is common to have a lame dog and no drawer motion – many of these dogs have a partial ACL tear. In such cases, forceful knee extension will elicit a pain response. Compare the patient's response to this test on the 'normal' leg first to see what they do. Direct palpation of the medial and lateral joint line may elicit a focal region of pain if the patient has a meniscal tear.

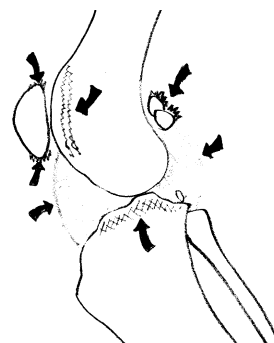
RADIOGRAPHIC INTERPRETATION

Mediolateral (M-L) and posterior-anterior (P-A) radiographic projections are typically taken above table using fine-screens if available. The settings can be adjusted to show osseous detail as well as illustrate soft tissue changes such as effusion and desmitis.

Radiographic changes consistent with degenerative joint disease lag behind articular pathology but become visible within weeks of the start of cruciate ligament pathology (both partial & complete tears). Look for osteophytes of the distal patella and the caudal aspect of the tibial plateau as well as at the insertion of the ACL. You may see subchondral sclerosis of the tibial plateau as well as fabellae and caudal tibial plateau osteophytes as the knee develops more arthritis.

Osteophytes will develop on the medial and lateral trochlear ridges and will also become radiographically apparent on the M-L view. Compression of the infrapatellar fat pad due to effusion will appear as loss of the triangular radiolucent triangle. You may also be able to appreciate caudal joint swelling seen as displacement of the muscle bellies posteriorly.

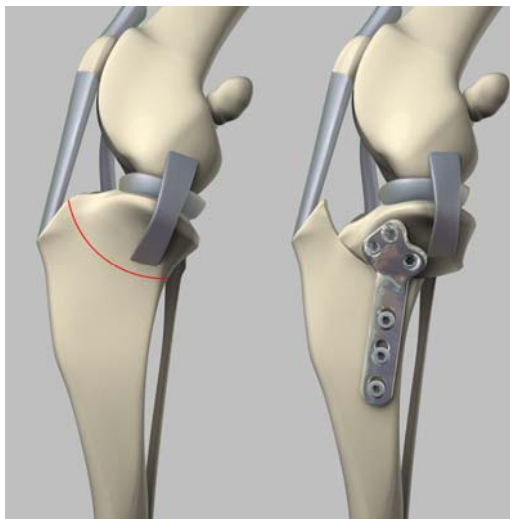
It is important in older dogs to ensure they do not have distal femoral or proximal tibial osteosarcoma rather than ACL disease.



What is the significance of the plateau slope?

In many studies, the normal caudal tibial plateau slope is consistently 23-27 degrees. This is accurate to 2 degrees either way over a number of observers who have been instructed on how to measure the slope. The slope generates a cranially directed force when the joint is compressed. This has been termed cranial tibial thrust by a famous vet called Dr. Slocum who pioneered TPO and TPLO.

The main function of the ACL is to resist cranial translation of the proximal tibia during physiologic loading. Steeper slopes result in larger tibial thrust forces with everything else being equal. The goal of tibial plateau levelling techniques as a treatment for ACL deficiency is to eliminate cranial tibial thrust by reducing the slope to 6 degrees. Here we see computerized models before and after TPLO.



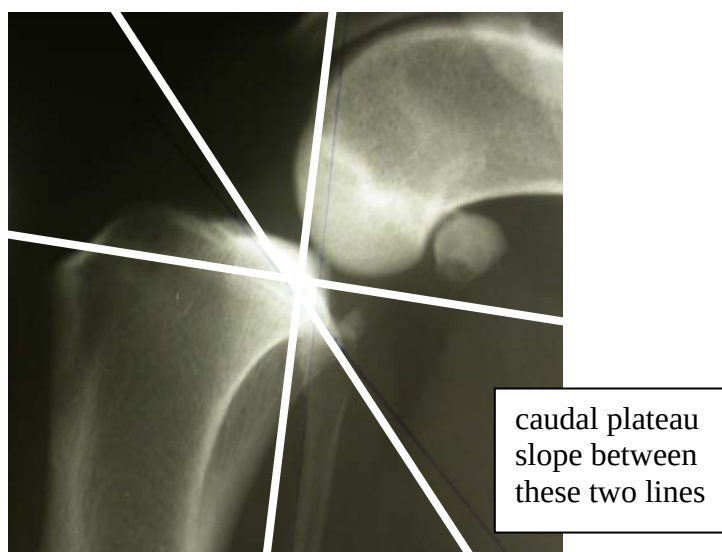
Why should I measure it and not a specialist?

In my opinion, many dogs seem to have excessive slopes in the range of 30-40 degrees and potentially the owners of these dogs should be informed of this as extracapsular techniques will be less favourable in their dog. This small breed dog has a slope of 45 degrees. A lateral fabellotibial prosthesis will have an increased chance of loosening due to the larger tensile forces it will undergo. Most practitioners regularly perform stifle radiography and teaching them to measure the caudal plateau slope from a well positioned lateral stifle radiograph should be achievable.



How do I accurately measure it?

We are trying to draw a line through the cranial and caudal aspects of the medial tibial plateau based on the lateral view radiograph. Place two dots on the radiograph and draw a line to connect them. It is helpful to know that if your line is accurate, it should be parallel to the centre of the medial tibial plateau. This cross referencing is useful when caudal plateau osteophytes obscure the caudal plateau landmark. A second line is drawn connecting the intercondylar eminences to the centre of the talar condyles distally. The beam of the lateral view radiograph should be centered on the stifle but collimated out to include the hock region. If we now draw a perpendicular to the second line at the intersection of the first two lines, the plateau slope is the angle of the slope from the perpendicular line.



SELECTION OF AN APPROPRIATE SURGICAL TECHNIQUE

Non-surgical management of ACL rupture in small dogs <10kg has been shown to produce acceptable clinical function by 12 weeks. Failure to improve or the development of a meniscal tear warrants surgical intervention.

Extensive research reveals that conservative management of ACL-deficient knees in larger dogs consistently leads to irreversible degenerative changes and DJD. ACL disease warrants surgery.

Arthroscopic diagnosis of partial tears, debridement of diseased cruciate stumps and meniscectomy is possible and veterinarians should accept this. Arthroscopy is less invasive, faster and has lower morbidity than arthrotomy. Training, experience and specific equipment are required.

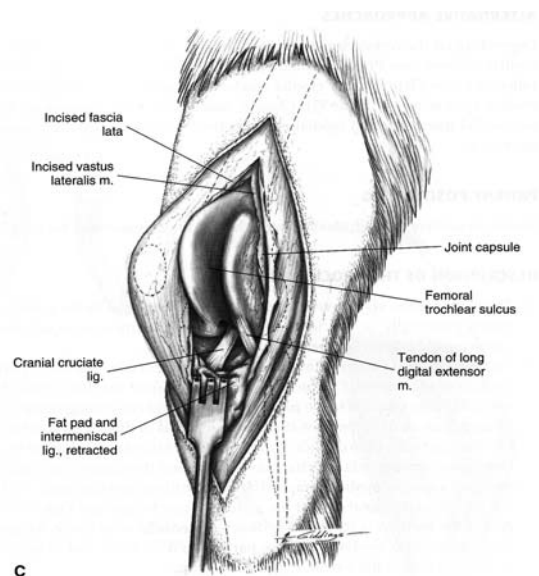
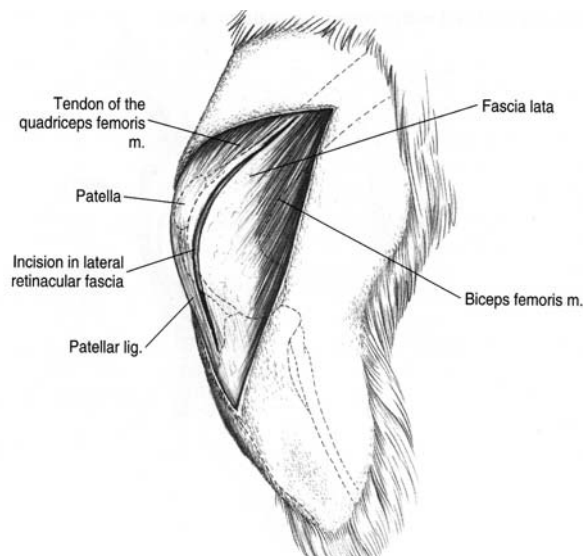
Extracapsular techniques (DeAngelis, fascial strip) can result in acceptable limb function however there is a higher incidence of late onset meniscal tears. Progressive osteoarthritis develops too. Plateau levelling techniques offer faster and less complicated recoveries and should be offered to all clients. Total knee is indicated if the knee has advanced degenerative changes or has not improved with reconstructive techniques.



CRANIO-LATERAL STIFLE ARTHROTOMY

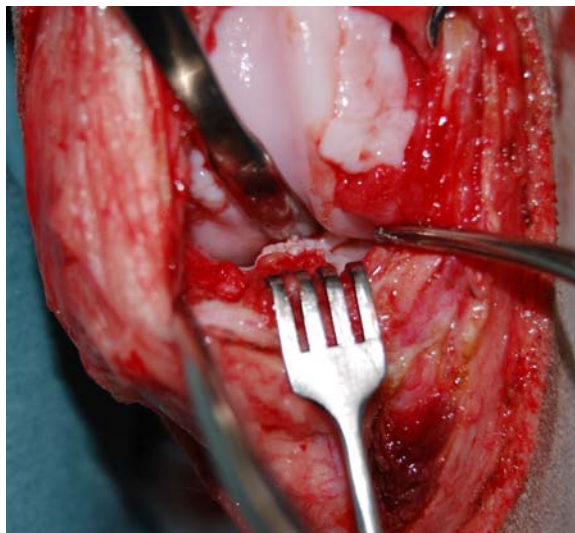
The standard lateral stifle arthrotomy provides exposure to the distal femur, tibial plateau, patella, cruciate ligaments and meniscal cartilages. The patient is positioned in lateral recumbency and the limb surgically prepared by a technique called 'free draping' which involves placement of four plain drapes and a cover for the foot followed by an over drape with a fenestration. This allows manipulation of the knee during surgery. Adhesive drapes and / or stitching in a drape to the dermis can be used to reduce infection risk.

A linear skin incision is made approximately one centimetre lateral to the patella towards the lateral aspect of the patellar tendon insertion. The centre of the incision is at the level of the patella. I like to use monopolar electrocautery to address skin bleeders as I continue the approach. Use blunt dissection of subcutaneous fat to find the underlying fascia. A linear incision in the fascia lata is made with a scalpel and a pair of scissors is used to undermine this layer both proximally and distally. Try to cut the fascia along the line of the original skin incision. I aim to cut the deep layer of the fascia lata along the cranial edge of the biceps femoris muscle. Distally the fascia lata joins the patellar tendon. A often palpate the patella and tibial tuberosity to ensure that my fascial incision is close to but lateral to the tendon distally. Continue onto bone.



A third linear incision is made into the joint along the lines of the first two incisions, slightly lateral to the patella. This will allow sutures to be passed through the joint capsule during closure. The suprapatellar pouch extends proximal to the femoral trochlea and to achieve maximal exposure you can extend your capsular approach all the way proximally. I like to first place a blunt instrument through the initial synovial opening to determine the most proximal extent of the joint prior to extending the synovial approach with scissors or electrocautery. Distally the fat pad may need to be excised and this carries minimal morbidity. The patella can be manually luxated to translate the quadriceps mechanism medially.

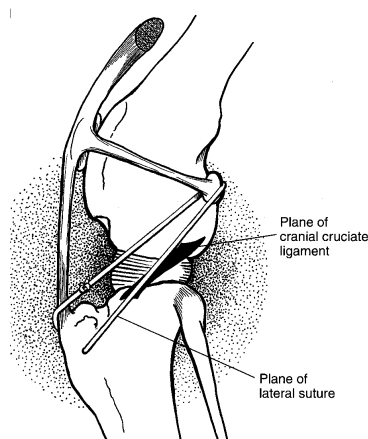
There are some simple steps to improve exposure once your approach has been completed. The first is to have a scrubbed assistant flex the knee and externally rotate the limb and brace the medial aspect of the stifle. Self-retaining Gelpi retractors can then be inserted within the joint capsule midway between the patella and tibial tuberosity. You can hook one arm of the retractor inside the tendon of origin of the long digital extensor. A toothed Senn retractor can be placed over the fat pad and pulled in a cranioventral direction. A medical grade suction unit with a fine tip (Frazier tip) is used to remove synovial fluid and blood. If the ACL is completely torn or is debrided (advanced partial tear), a narrow Hohmann retractor is used to level the tibia anteriorly allowing visualisation of the caudal joint compartment. The tip of the instrument is carefully inserted deep into the knee between the femoral condyles and placed caudal to the tibia. The assistant can then push the handle caudally and the retractor will lever the tibia anteriorly relative to the distal femur.



EXTRACAPSULAR TECHNIQUES

Numerous procedures have been reported to address stifle instability. These procedures can be broadly categorised as extracapsular or intracapsular techniques. With all of these techniques, recoveries are prolonged, joint range of motion is reduced long term, laxity returns in many cases and osteoarthritis is progressive. There appears to be little correlation between the development of recurrent laxity and limb function. Clinically, these techniques are worthwhile in most patients and can be performed by veterinarians who are familiar with stifle anatomy and who have basic surgical instrumentation.

The most common extra-articular technique is the use of a large, nonabsorbable, lateral fabello-tibial suture such as nylon (fishing line), braided polyester or orthopaedic wire. The orientation of this prosthesis approximates the direction of the ACL. The suture is passed through or around the fabello-femoral ligament and through a predrilled transverse, tibial crest bone tunnel.

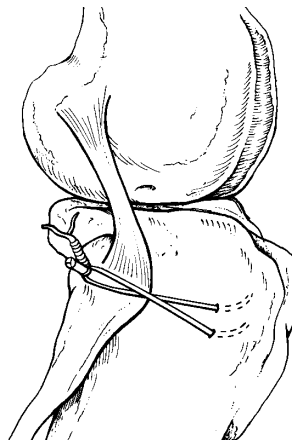


Recently, a metal clamping system has become commercially available to hold nylon sutures with the advantage of increased knot security and the avoidance of large knots which can cause soft tissue irritation. Over time all of these sutures break or loosen. The intention is for the sutures to maintain joint stability until periarticular fibrosis stabilises the joint. This prosthesis alters stifle kinematics and eliminates internal tibial rotation during flexion. In addition, the lateral joint compartment is compressed and the articular cartilage undergoes degeneration. The most common complication is chronic foreign body reaction resulting in a

draining tract reported in one study in 21% of 161 cases. Imbrication of the facia lata can be used as an adjunct procedure but should not be used as the sole method of stabilisation.



Fibular head transposition is an extra-articular repair technique that uses the lateral collateral ligament (LCL) to stabilise the stifle joint. The LCL runs from the lateral epicondyle of the femur to the fibular head. Ligamentous connections between the fibular head and tibia are cut and the fibular head transposed cranially and secured with pins and a tension band wire. The orientation of the LCL is redirected to approximate that of the ACL.

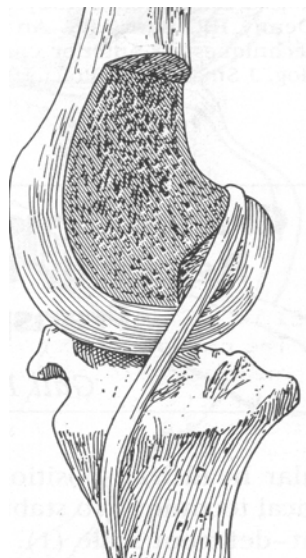


Research evaluation showed that the technique did not control cranial drawer motion or rotational instability, was not successful in restoring limb function, and did not prevent DJD. Significant elongation and hypertrophy of the LCL occurred over the first postoperative month. Potential complications include iatrogenic fibular head fracture, implant failure and peroneal nerve damage.

Intra-articular techniques involve the placement of grafts (biologic) or prostheses (synthetic) within the joint to replace the ACL

anatomically and functionally. The most common canine technique involves the use of autogenous tissue harvested from the patellar tendon and fascia lata which is passed through the joint and secured to the lateral femoral epicondyle. Adequate tension and placement are necessary for postoperative stability.

It is not possible to place grafts isometrically (so that they do not change length throughout a full range of motion) without creation of articular bone tunnels. Tissue grafts weaken and take several weeks to attain full mechanical strength which is only about 30% of that of the intact ACL. Many surgeons augment these grafts with extra-articular prostheses to protect them from mechanical failure during the postoperative period. In my experience, the additional time and effort involved in placement of intra-articular grafts or prostheses fail to deliver significantly superior outcomes to simpler extra-articular repairs. These techniques may be preferred for cases with minimal OA as the hostile environment inherent associated with OA may preclude graft incorporation and remodeling.



PERIOPERATIVE ANALGESIA

Significant advances in our understanding of pain pathways, physiology and recognition of pain in canine patients have been made in recent years. Many prospective, controlled, double-blinded, experimental and clinical live animal studies have documented the beneficial effects of perioperative analgesics in surgical patients often using stifle surgery as a model. The philosophy of a multi-modality approach to pain control has been accepted by the veterinary community and involves the use of

different drugs simultaneously, each with a unique mechanism of action. Pre-emptive administration of analgesics, prior to the initiation of surgery, has been shown to reduce peripheral sensitivity to noxious stimuli and be more effective than the identical drug at the same dose rate given postoperatively. Cyclo-oxygenase specificity of newer generation NSAIDs is the most likely explanation for improved efficacy with less toxicity than traditional NSAIDs.



Morphine forms the backbone of our current analgesia with 0.3-0.5mg/kg administered parenterally q. 2-6 hourly for 24 hours. Epidural administration of 0.2 mg/kg (diluted in LRS 1ml per 10 kg) preservative-free morphine acts for 18-24 hours and is best given prior to surgery as it takes 45 minutes to work.

It is appropriate to administer oral analgesic agents in the form of NSAIDs for several weeks following successful surgery for the cruciate-deficient stifle. This encourages limited limb use and weight bearing which improves muscle tone, maintains joint range of motion and preserves cartilage metabolism. Limited limb use and / or immobilisation is detrimental to long term limb function especially at the joint level and permanent degenerative changes may develop such as capsular fibrosis, superficial cartilage fibrillation and chondromalacia which are the early changes of osteoarthritis.

Tramadol is a relatively newer opioid that has become available for oral use in dogs. It is safe and allows more aggressive ongoing analgesia if NSAIDs alone are not effective. The dosage can be incrementally increased to effect with safety.

Physical therapy can be encouraged in the postoperative period. Active physical therapy in the form of limited leashed walks and swimming are preferred. A recent clinical trial documented positive benefits in terms of limb use and improvements in thigh

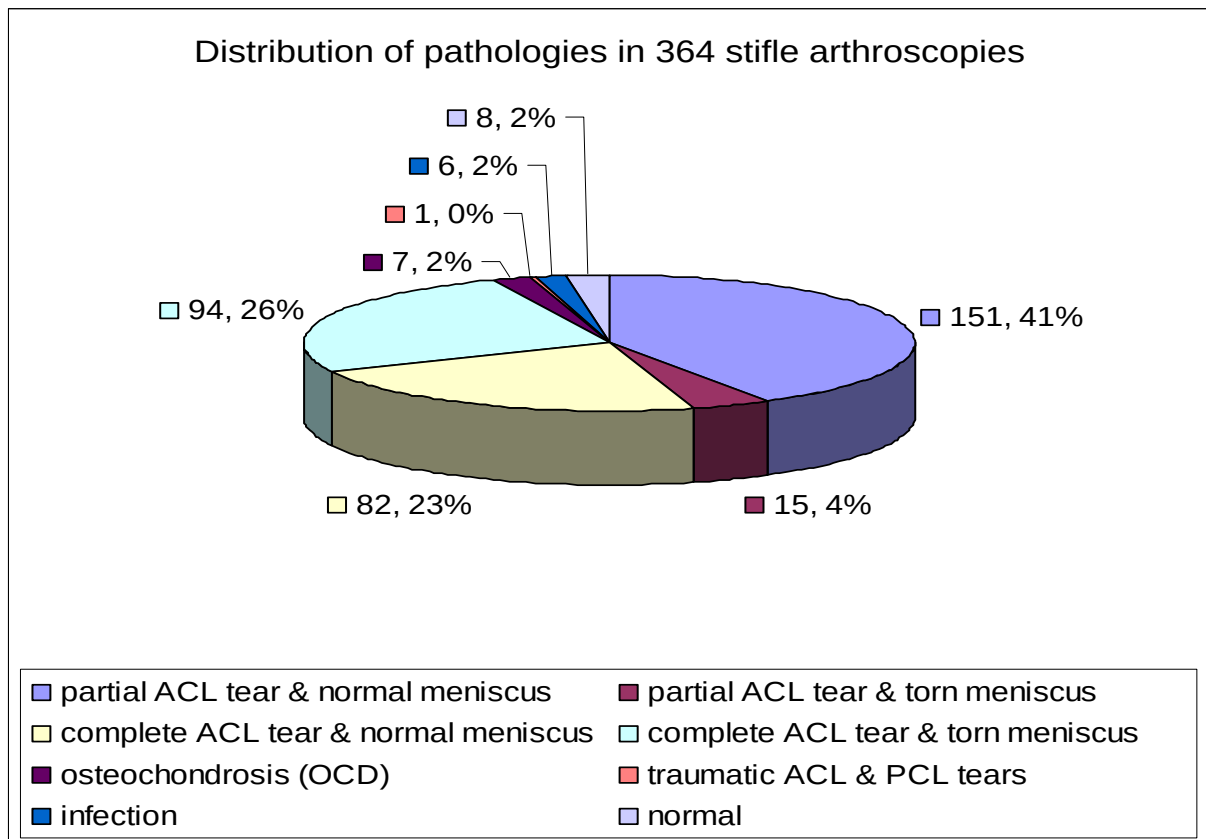
muscle circumference, when comparing twice daily hydrotherapy to cage rest in post-surgical cruciate cases. In my opinion, passive range of motion exercises to maintain joint range of motion by preventing tissue adhesions re difficult for many owners to perform at home but should be offered and encouraged to all owners.

KNEE ARTHROSCOPY

Arthroscopy offers improved visualisation, less pain and lower morbidity relative to arthrotomy. Canine stifle arthroscopy is in its infancy compared to the worldwide acceptance of knee arthroscopy in man. The human knee is significantly larger and the reduced morbidity is of more significance especially in athletes. Small joint arthroscopes and hand instruments are available to resect and retrieve meniscal fragments under direct observation. There is a steep learning curve for canine stifle arthroscopy in dogs. We use endoscopes, fitted with a light source, to evaluate the inside of joints. Small skin incisions are made and a series of blunt probes are used assess intra-articular structures. The challenges with the canine knee are its smaller size and relatively larger intrapatellar fat pad that is very vascular.

Stifle arthroscopy is faster than open arthrotomy. It provides an opportunity to establish a definitive diagnosis in suspect knees prior to performing a more aggressive procedure (eg. osteotomy). Client acceptance is high. A limited number of specialist surgeons claim to be able to perform partial meniscectomies consistently. Our opinion is that this is a growth area and will become accepted as the optimal modality in the diagnosis and treatment of meniscal pathology. The barrier is acceptance by veterinarians.





PLATEAU LEVELLING TECHNIQUES

Corrective osteotomy

Over the past decade, veterinary orthopaedists have come to respect and recommend corrective osteotomies of the proximal tibia as their preferred approach in the management of canine patients with diseases of the cranial cruciate ligament. These procedures are powerful techniques and can deliver dependable outcomes in the vast majority of cases. They are complex and require experience and advanced training to avoid the more common technical pitfalls and minimize patient morbidity.

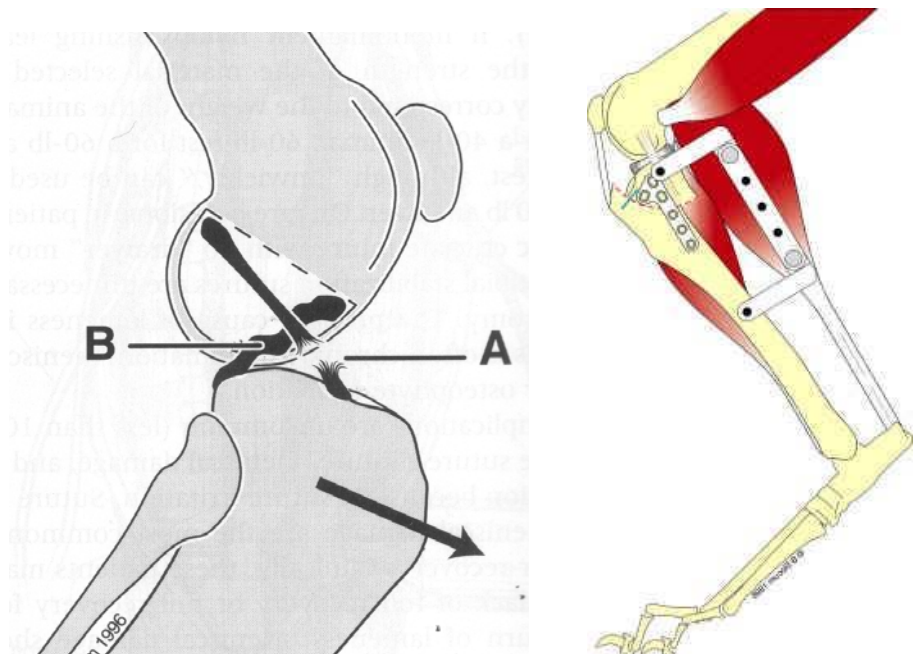
The principle of improving joint biomechanical function by performing a corrective osteotomy is well established in the orthopaedic community. Joints are composed of articulating cartilage surfaces which transfer physiologic loads. An unstable joint environment, such as is the case in the cruciate-deficient stifle, results in abnormal load distribution within the cartilage and underlying subchondral bone. Secondary osteoarthritis ensues. The goal of a corrective osteotomy is to alter the mechanical environment to improve load distribution and joint function and

preserve the joint or minimize the progressive degenerative changes which develop. An understanding of the biomechanical function of normal and diseased joints is required. Common examples include proximal tibial varus osteotomies in human patients with unicompartmental knee osteoarthritis to delay total knee replacement and pelvic osteotomy to restore joint stability in human and canine hip dysplasia.

Cranial tibial thrust

Unlike the situation in the human knee where the bearing surface of the proximal tibia is perpendicular to the long axis of the bone, the canine stifle possesses unique anatomy. The articular surface of the proximal tibia is caudally sloped relative to the functional tibial axis. During weight bearing, the gravitational forces directed through the limb, combined with compressive forces generated by contraction of the gastrocnemius muscles, result in tibial compression.

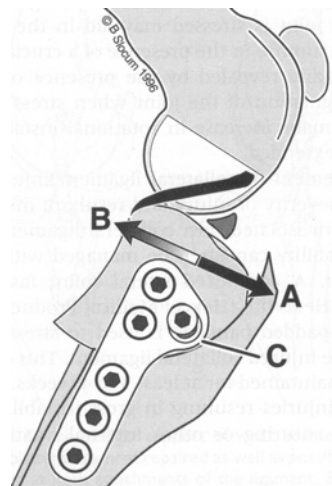
A cranially directed force, called tibial thrust, is generated which results from compression of the cylindrical femoral condyles on a sloped tibial plateau. This force is normally balanced by active muscular contraction of the hamstring muscle group pulling the proximal tibia caudally and opposed by the intact ACL. Following cruciate rupture, muscular forces alone cannot compensate for loss of the ACL and dynamic anterior tibial subluxation occurs during the stance phase of the gait cycle.



TPLO in vitro model

A landmark experimental study was published in the *Journal of Veterinary Surgery* in 1999 evaluating the effect of tibial plateau levelling on stifle stability. This work was completed at the comparative orthopaedic laboratory at Michigan State University by Dr. Steven Arnosky and his research group, who are highly regarded in the area of canine stifle and human knee studies. The goals of this study were to simulate *in vivo* loading conditions by creating an anatomic model with preservation of important stabilising structures around the stifle including the collateral and cruciate ligaments and both medial and lateral menisci. The quadriceps and gastrocnemius myotendinous units spanning the stifle and tibiotarsal joints were simulated with adjustable cables to enable simulation of muscular contraction. An axial load was applied from the femoral head to the paw to simulate the compressive forces across the stifle during the stance phase of the gait cycle.

In normal joints following artificial transection of the ACL, plateau levelling produces functional stifle stability during loading due to the constraint of the intact caudal cruciate ligament. The minimum angle of rotation required to achieve functional stability is approximately 6.5° less than the levelling angle which would create a perpendicular between the proximal tibial bearing surface and the functional axis of the tibia. It was discovered that over-rotation of the tibial bearing surface likely would predispose the caudal cruciate ligament to chronic fatigue failure due to excessive loading. Rupture of the caudal cruciate ligament is a recognised complication of this procedure. Excessive internal rotation of the cruciate deficient stifle is partially addressed with tibial plateau levelling.



Tibial plateau levelling osteotomy

Tibial plateau levelling as a primary and sole treatment for rupture of the cruciate ligament is not a new or novel technique. It has been performed widely for many years overseas and has gained widespread acceptance. A recent mail survey of Diplomates of the American College of Veterinary Surgeons, who specialize in small animal surgery, revealed that two-thirds of respondents recommend TPLO surgery as their preferred technique in the treatment of cruciate ligament disease.

The goal is to eliminate or neutralise the cranial tibial thrust force vector and therefore stop cranial tibial subluxation. Caudal tibial thrust is created instead, however the magnitude of this force is smaller than before levelling. Functional stability is created due to the integrity of the caudal cruciate ligament which prevents caudal drawer motion. Plateau levelling procedures do not address passive stifle laxity and drawer motion can still be achieved during orthopaedic examination.



The most popular and researched technique in achieving a levelled proximal tibial bearing surface is to perform a TPLO using a circular or curved osteotomy in the proximal metaphysis as described by the late Dr. Barclay Slocum. A custom compression plate is applied to the medial aspect of the tibia.

This TPLO procedure has been refined over thousands of cases and offers numerous mechanical and biologic advantages over other techniques. The TPLO technique was clouded with controversy as this has been the only procedure in veterinary medicine that has been patented (1983-2003). This annoyed many people and restricted its use to those who completed a training course in Oregon and became certified. The most common alternative technique is a closing wedge osteotomy (CWO) where a wedge of bone, with the apex directed caudally, is removed which results in shortening of the cranial aspect of the diaphysis whilst maintaining the length of the caudal aspect. This procedure can be performed without specialised TPLO equipment. Mechanical disadvantages include no fragment interdigitation at the osteotomy interface to resist rotational and shearing forces, a location towards the centre of the diaphysis increasing the bending moment arm and resultant bending forces and the smaller cross-sectional bone diameter for screw purchase relative to the wider metaphysis. Biologically, the advantage of a curved metaphyseal osteotomy is the larger surface area available to contribute to bone healing and the higher healing rate and capability of cancellous bone. Potential complications associated with the TPLO procedure include fracture of the tibial tuberosity, implant failure, screw placement within the joint, delayed bone healing, over-rotation and caudal cruciate ligament rupture and iatrogenic limb deformities.



Tibial plateau levelling procedures are accepted, appropriate treatments for both partial and complete cruciate injuries. Muscle bulk consistently improves, joint range of motion is preserved and patients return to preinjury function. These techniques are widely available in Australia and can be recommended with confidence to pet owners. In my opinion, all practitioners who make recommendations to clients with cruciate injuries should be aware that they exist and offer these procedures in the appropriate setting. The discovery that corrective osteotomies can be successfully applied to the cruciate-deficient stifle has greatly improved our prognosis for the most common cause of pelvic limb lameness and should both intrigue the scientist and reward the clinician.

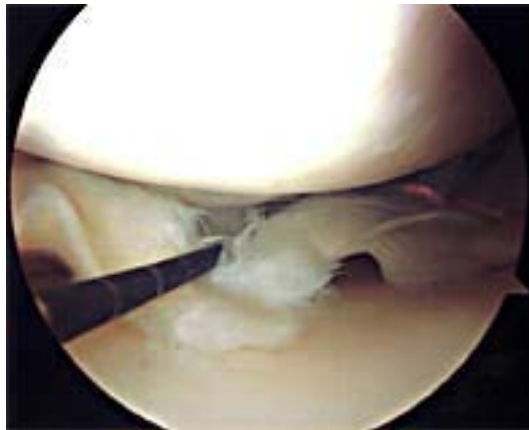


- Corrective osteotomies of the proximal tibial plateau (TPLO, CWO, TTO, TTA) improve stifle function by elimination of cranial tibial thrust
- Functional stability, in a cruciate-deficient stifle, is restored by creating caudal tibial thrust in a joint with an intact caudal or posterior cruciate ligament
- Anterior tibial subluxation during the stance phase of the gait cycle is eliminated
- Clinically, the functional results appear to consistently restore athletic function in joints with minimal degenerative changes

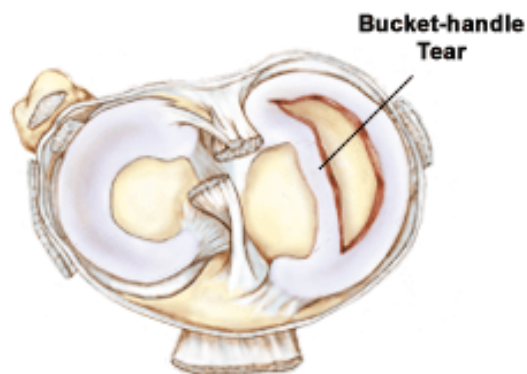
MENISCAL INJURIES AND TREATMENT

The vast majority of canine meniscal tears involve the caudal horn of the medial meniscus due to the asymmetric ligamentous attachments of the meniscal bodies to the tibia and femur. The medial meniscus has a strong attachment to the medial collateral ligament and has a caudal meniscotibial ligament. In contrast, the lateral meniscus can move freely relative to the lateral collateral ligament and a menisiofemoral ligament attaches the caudal aspect of the lateral meniscus to the lateral condyle of the femur. In the cruciate deficient stifle, cranial tibial subluxation results in impingement of the caudal horn of the medial meniscus between the femoral condyle and the proximal tibia. The caudal aspect of the lateral meniscus is able to move caudally relative to the tibia and avoid the crushing damage sustained by the medial meniscus.

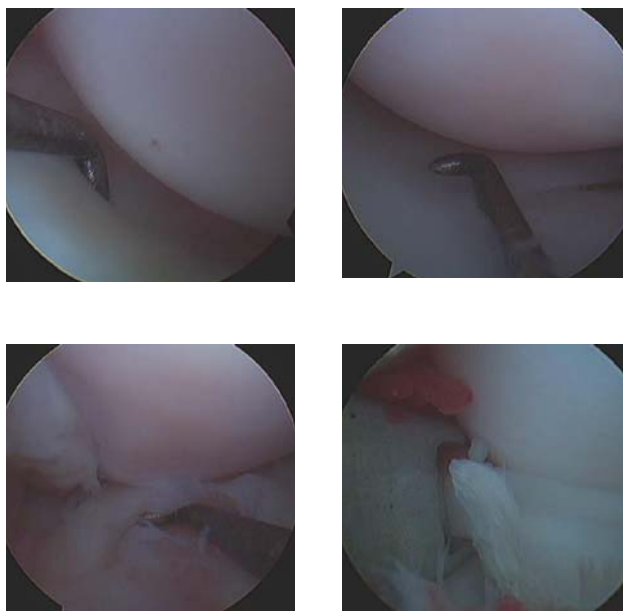
The outer or peripheral 25% of the meniscus is vascularised and has healing potential. Only acute, so called "red-zone" tears can be repaired in human arthroscopic knee surgery. The majority of canine meniscal injuries are inner or axial tears within the avascular zone and these lesions do not heal.



"Bucket handle" tears are a form of longitudinal tear where the axial section of the meniscus is able to move craniomedially away from the body of the meniscus but still remain attached cranially and caudally. These tears are able to create a clicking sensation which can often be palpated during manipulation of the joint or heard when the patient is walking. The free or mobile meniscal tissue translates cranial and caudal to the femoral condyle as the joint passes through a range of motion.



Arthroscopic probing is a sensitive technique to diagnose meniscal tears. Partial meniscectomy using cutting instruments can be performed under excellent visualization.

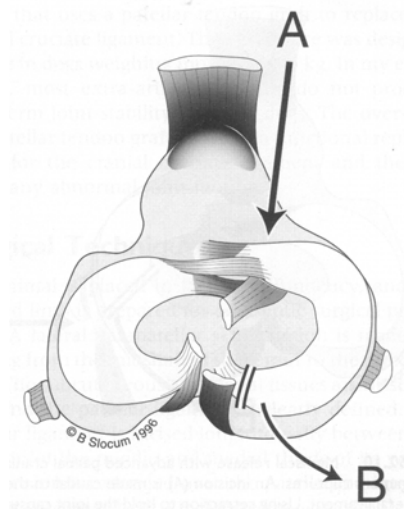


Meniscal Surgery

The high incidence of meniscal pathology associated with ACL injury warrants aggressive evaluation of existing meniscal tears and prophylactic intervention to prevent subsequent impingement. It has been documented that the incidence of meniscal injuries correlates with patient size and duration of instability. Smaller patients and patients with partial ACL injuries have a considerably lower incidence of meniscal tears. **Meniscectomy is the permanent removal of meniscal tissue and is appropriate to address existing meniscal pathology.** The outer or peripheral rim of the meniscal body is the thickest and most important region of the meniscus functionally and should be preserved if possible. Partial or subtotal meniscectomies are preferred over total meniscectomies as they preserve the cranial horn and the peripheral rim which minimise the progression of osteoarthritis.

Recently, veterinary orthopaedists have been performing procedures which are termed meniscal releases. These procedures are controversial as they potentially eliminate the function of the medial meniscus. There are two forms of meniscal release described based on the approach to the joint.

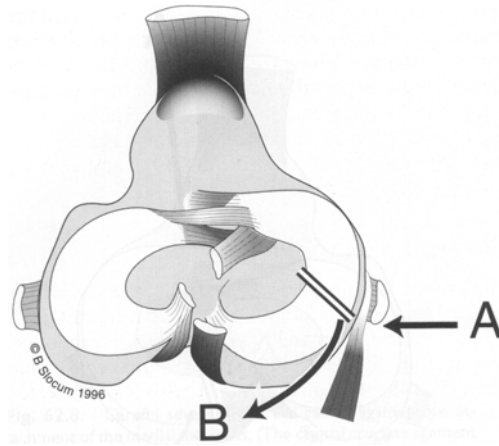
Transection of the meniscotibial ligament which attaches the medial meniscus to the proximal tibia, via a craniolateral or craniomedial arthrotomy, can be achieved with a low profile, end-cutting blade.



A = craniomedial arthrotomy and direction of approach

B = direction caudal horn is able to move after release

Alternatively, a mid-body transection via a caudomedial arthrotomy, caudal to the medial collateral ligament, can be performed through the same approach to perform a TPLO on the medial aspect of the tibia. The caudomedial approach does not offer evaluation of meniscal tissue prior to transection of the meniscal body.



A = caudomedial approach caudal to medial collateral ligament

B = direction caudal horn is able to move after release

Both procedures allow the caudal horn of the medial meniscus to translate caudally in an unstable joint and avoid impingement. Retrospective clinical reports support the efficacy of these procedures in preventing lameness due to later meniscal pathology after a successful procedure to address cruciate deficiency. However, meniscal release eliminates function of the caudal horn and OA progresses.

- Late onset meniscal tears represent a common complication after ACL surgery:
 - o Highest incidence after DeAngelis (TTA? TTO?)
 - o Lower incidence after TPLO, CWO
- Prophylactic intervention to reduce incidence meniscal tears = meniscal release:
- Meniscal release not benign - will cause DJD / OA
- Current clinical recommendations:
 - o DeAngelis – meniscal release accepted
 - o TPLO – meniscal release not warranted

TOTAL KNEE REPLACEMENT

Introduction

Total Knee Replacement (TKR) is a well established procedure in humans for the treatment of osteoarthritis in the knee. It is performed in over 600,000 patients annually world wide. The procedure has a high success rate lasting in 90-95% of patients an average of 15 years.

The procedure is now clinically available in canine patients after being developed in the United States by the Biomedtrix Corporation in 2007. The procedure has been performed in 30 patients at the time of writing. Of these, 17 TKRs have been performed in Houston, Texas, one in Birmingham, UK and 12 in Australia in Sydney and Melbourne. The first TKR in the Southern Hemisphere was performed in 2008 at the Animal Surgery Centre.

TKR is designed for canine patients with hindlimb lameness from osteoarthritis of the stifle. Potential patients may be chronic cruciate cases, have had a previous surgery (e.g. DeAngelis procedure) that has failed, or have had other forms of stifle pathology such as complicated patella luxation, immune mediated disease or post-traumatic osteoarthritis. Early results show the procedure is effective in most dogs.



History

Total knee replacement in the human has a history dating back to the late 1950s. The first attempt was a prosthesis which was a hinge fixed in the medullary canals. They provided short term pain relief however had reduced range of motion and suffered from loosening and infection. At the same time, metal spacers were trialled in joints in order to stop bone rubbing, however these were not clinically effective. In 1968 a Canadian surgeon called Frank Gunston from Sir John Charnley's hip centre developed the first metal on plastic knee which was cemented into place. In 1972 John Insall designed a prosthesis which was the prototype for today's current human TKR prostheses at the Hospital for Special Surgery, in New York. He is considered the Father of Knee Arthroplasty.

In the veterinary setting, canine and ovine patients have been used in the development of human prostheses right from the beginning. Dr Tom Turner in Chicago was the first to develop a research model of a canine TKR which he did in association with Rush Presbyterian Hospital in Chicago. This prosthesis was cemented in place and fixed to the tibia with screw fixation (delete fixation). Dr Bill Liska from Texas in conjunction with Biomedtrix developed the first clinical based TKR system for the canine patient.

Background Training

We undertook specific training in human hospitals (The Mater and Westmead Private in Sydney and The Valley Private in Melbourne) in order to gain experience in human TKR. We also consulted with Stryker Medical and Smith & Nephew, human biomedical companies at the forefront of prosthesis design and manufacture. We travelled to Houston, Texas and spent time training under Dr Bill Liska who developed the technique in dogs. Our introduction was to practice the technique on multiple cadavers which helped gain experience with the instrumentation and implants prior to clinical use. We have been fortunate to have a human knee surgeon, based in Melbourne, involved in the first 4 TKR surgeries in Australia. This individual has also reviewed many of the postoperative radiographs to provide ongoing advice and technical support.

Patient Selection

1. Failed DeAngelis Procedure

The first patient group that should be considered for a TKR is dogs that have undergone a form of anterior cruciate ligament (ACL) repair that has failed to return the dog to a satisfactory (good) level of soundness. The most common failure is seen in dogs that have a lateral fabella to tibial crest suture or DeAngelis procedure. In these cases, there is frequently recurrent instability because the fishing line has either avulsed off the fabella or broken. There is frequently advanced osteoarthritis and sometimes a medial meniscal tear will be present. It is essential to ensure there are no signs of joint or leader line infection actively present.



2. Chronic Cruciate Patients

TKR is not designed to replace existing cruciate repair techniques e.g. TPLO, when the disease is diagnosed early. Cruciate ligament disease in most patients, especially in larger patients, is a degenerative condition. As the ligament weakens and progressively fails, the joint is undergoing concurrent degeneration and develops osteoarthritis quite rapidly. If instability (cranial drawer or tibial thrust) is the primary problem then stabilisation via DeAngelis or TPLO is still warranted. If instability and significant osteoarthritis are present, then a TKR should be considered as a treatment option. In these cases stabilisation will not relieve the pain associated with OA.



3. Complex Medial Patella Luxation

Most cases of MPL still need to be dealt with traditional techniques such as sulcoplasty, tibial tuberosity transposition, soft tissue tightening procedures and occasional femoral varus osteotomy. In cases of deformation of the articular stifle structures, TKR can be used successfully.



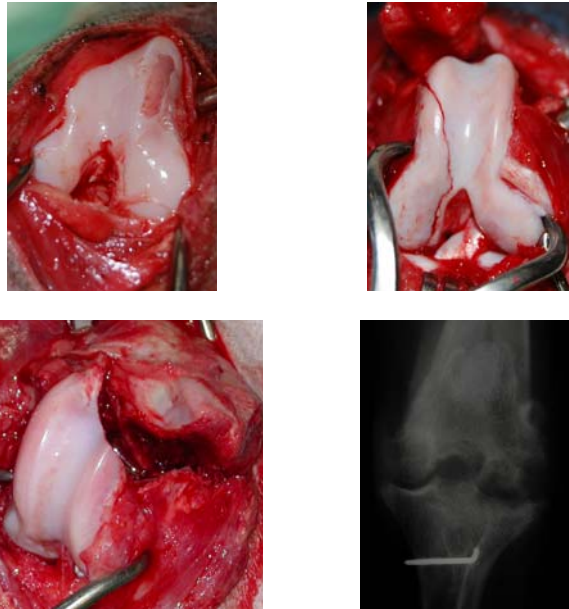
4. Stifle Osteochondrosis

Distal femoral OCD is most commonly seen in large or giant breed dogs and presents as a juvenile lameness that can be quite severe. Initial management involves arthroscopic or open removal of the flap and forage/curettage of the subchondral bed. Most dogs develop significant osteoarthritis at a later date and may have associated lameness. In these cases a TKR can be used later in the life as a resurfacing procedure.



5. Trauma

In dogs that have had previous stifle trauma and fractures, it is now feasible to offer a delayed revision surgery and replace the diseased arthritic joint. Such condition may include: malunion of a distal femoral physeal fracture, malunion of a femoral condylar fracture, DJD secondary to a luxated stifle with marked periarticular fibrosis and proximal tibial plateau injuries secondary to trauma.



Contraindications

1. Neoplasia involving the distal femur, proximal tibia or soft tissues (eg. synovial cell sarcoma)
2. Infection either localised such as a chronic septic knee or remote such as marked periodontal disease, UTI or pyoderma.
3. Insufficient patient size – the current range of implant will only accommodate dogs over 15-20kg bodyweight
4. Lack of owner compliance with regard to controlling exercise, use of an Elizabethan head collar and administration of medications
5. Inability to provide physical therapy at home. We have used passive stifle range of motion and assisted standing exercises with success.

6. Patients with acceptable limb use and function when medicated with NSAIDs and other therapies. A candidate may have advanced degenerative changes radiographically, but must also have pain and associated disability to warrant the costs and risks of elective total joint arthroplasty.
7. Primary pathologies involving the patella or patellar tendon such as fracture of the patella, patella alta / baja or patellar rupture / avulsion / laceration.



Preoperative Planning

It is important to do a full physical, neurological and orthopaedic examination on the patient to rule out other medical conditions. Like in other arthroplasty procedures, skin, ear and dental infections should be ruled out.

The stifle needs to be examined with the patient awake and asleep in order to gauge the level of pain, presence of cranial drawer and tibial thrust, the competency of the collateral ligaments and the level of joint effusion. Very importantly the range of motion should be assessed preoperatively. TKR offers the ability to increase the degree of flexion and extension, as well as improve limb alignment (eg. correct genu varus). Muscle atrophy can be

measured preoperatively and followed in the postoperative period and used as one measure of success. The degree of buttress and medial joint thickening is important to understand as it will impact operative decision making.



Identifying those chronic knees that have failed traditional reconstructive surgeries (eg, DeAngelis, fascial strip) due to the presence of low-grade infection is challenging. Preoperative arthrocentesis and culture of the aspirated fluid is relatively insensitive in definitively diagnosing infectious agents. Synovial membrane biopsy, via arthrotomy or arthroscopy, will be more sensitive than synovial fluid sampling, in its ability to definitely diagnose an infection but requires a second procedure with associated costs. All clients should be informed that intraoperative assessment of the joint may reveal abnormal synovial discoloration and a high degree of risk for the presence of infection. In this circumstance, knee replacement surgery should not proceed.



Analgesia

In people TKR is considered a painful procedure, in fact more painful than a total hip replacement. Our early clinical observation suggests TKR in dogs can allow for early limb use in half of the dogs but others hold the limb off the ground in flexion and require physical therapy. The level of postoperative pain seems to vary between patients but in some dogs does not seem to be more than

that associated with an osteotomy (i.e. TPLO). Patients are premedicated with ACP and morphine. The morphine provides approximately 4 hours of analgesia and is a potent *mu* agonist opioid drug. Some of our patients have received a morphine epidural as well as bupivacaine into the regional periarticular soft tissues. Postoperatively the dogs have received morphine overnight as required and have been discharged on a NSAID and/or tramadol for 5-7 days. We believe that further caseload experience will enable us to establish the ideal postoperative medical regime. At this point it appears that the duration of supportive analgesia may need to be tailor to each individual patient.

Antibiotic Protocol

Dogs have been administered Cefazolin 22mg/kg preoperatively at induction and every 90 minutes during the procedure. Cefazolin powder is added to the polymethylmethacrylate (bone cement) before curing. Postoperatively the patients have been placed on amoxycillin clavulanate prophylactically for 5-7 days.

Templating

Craniocaudal and mediolateral radiographs of the affected stifle are taken with a custom made magnification marker to determine the percentage magnification associated with taking the radiograph. This in general varies from 8-12%. Full-length anterior-posterior views of the femur and tibia are useful to assess bowing and angulation abnormalities of the femur and tibia preoperatively. Distal femoral and proximal tibial valgus /varus deformity can be addressed during surgery to improve limb alignment and limit wearing of the implant surfaces. Measurement of the tibial plateau angle (TPA) is important as it will dictate the depth and angulation of the tibial osteotomy. Acetate templates are superimposed onto the distal femur and proximal tibia to select the most appropriate implants for each patient.



Skin Preparation and Draping

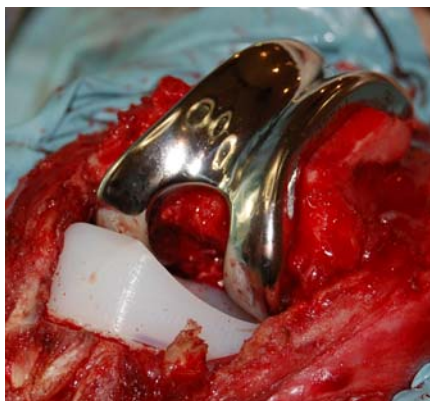
The limb is suspended from the ceiling and clipped for surgery. The hock is included because of the need to place the tibial jig. The skin is cleaned with chlorhexidine solution. A 70% isopropyl alcohol spray is applied followed by a chlorhexidine tint (4% chlorhexidine in alcohol). In the theatre, the surgeon applies the final preparation painting a combination of either chlorhexidine and alcohol or povidine iodine and alcohol over the limb. Disposable single use four corner draping (Huck Towels) isolates the limb. A human orthopaedic stockinette with mesh woven cotton and impermeable fluid resistant outer is placed over the limb. A final water impermeable sterile single use orthopaedic drape is used as the final barrier. The skin is incised and the stockinette sutured to the dermis which isolates the hair follicle and assists with lowering operative contamination of the surgical site.



Components

The femoral component is constructed of cobalt chromium and is bead blasted on the undersurface. It is bicondylar and mimics the anatomy of the distal femur. The femoral sulcus is long extending dorsally. There is a post on the back of the implant with a cruciform shape to provide additional rotational security. The femoral component is designed to be cementless. Initially friction with the underlying cancellous bone provides short term security. Longer term osteointegration occurs with bone ingrowth. There are four surfaces of contact with the distal femoral bone. The cranial and caudal surfaces are offset by a predetermined angle of 10 degrees. This provides a locking mechanism via a taper fit. There are seven different sizes of femoral component. They are designed to fit animals from roughly 15-20 up to the largest of dogs.

The tibial component is constructed of ultra high molecular weight polyethylene. There are five sizes each having three thickness (in two millimetre increments). There is no ramp or post caudally for caudal cruciate stability. There again is a post / peg on the undersurface of the tibial component to provide stabilization. The undersurface of the implant is recessed in order to allow enhanced cement contact. The weight bearing surface is concave and has been designed to mimic the concavity and abaxial support of the meniscii.



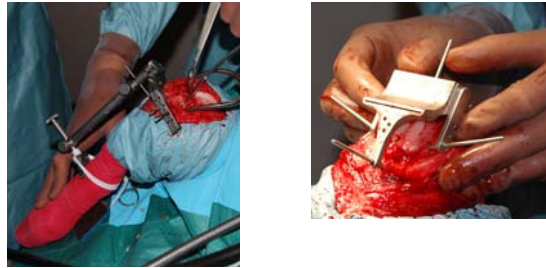
All femoral components are compatible and can be used with all of the different tibial components. This modularity offers the surgeon freedom to choose the femoral and tibial implant sizes independently. Trial components for each size of implant are available to use operatively.

A tibial jig is used to create the proximal tibial cut. The jig is designed to make a cut at 6 degrees to the long axis of the tibia and creates a tibial plateau angle of 6 degrees. The normal TPA is approximately 24 degrees. By reducing or levelling the slope to 6 degrees, in effect a TPLO is performed. This is important in providing stability for the TKR prostheses. The tibial jig is attached to the distal tibia, tibial crest and proximal tibia using multiple K wires. The jig is removed following osteotomy of the proximal tibia.

The femoral jig is designed to perform four osteotomies that match the undersurface of the femoral prosthesis. The jig is held in contact with the distal aspect of the femoral condyles and is attached to the anterior and lateral surfaces of the distal femur using K-wires. A custom saw blade is used to perform the four sequential osteotomies through a series of slots in the femoral jig. Stryker cordless battery driven System 4 reciprocating saws are used and Stryker 4200 cordless battery driven drill with reamers,

wire collets and Jacob's chuck attachments are used as power equipment.

The methodology of the femoral and tibial cuts and use of alignment jigs is similar to the commonly performed human knee replacement techniques.

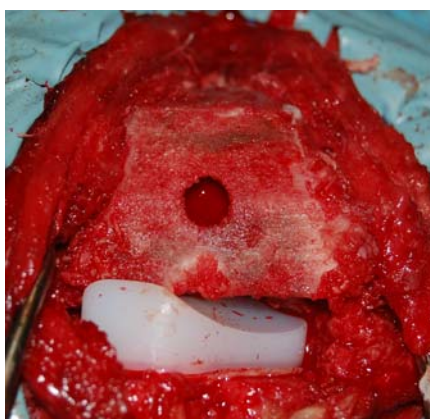
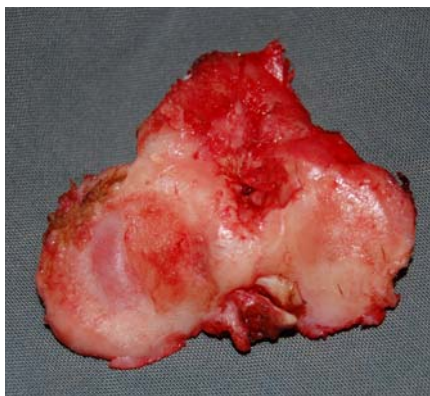


Operative Technique

Patients are placed in dorsal recumbency with a slight tilt in the surgical table (head higher). A traditional lateral parapatellar approach is made for stifle arthrotomy. It should be noted a medial approach can also be used, and we have used this in one case. The long digital extensor tendon is released from the fossa and tagged for later re-attachment to the joint capsule. The joint capsule is incised proximally to its full extent to achieve maximal joint exposure. The bursa of the patellar tendon insertion on the tibia is opened. Infrapatellar fat pad, cranial and caudal cruciate ligaments as well as both medial and lateral menisci are excised *en bloc*. Hohmann retractors place the tibia into drawer.

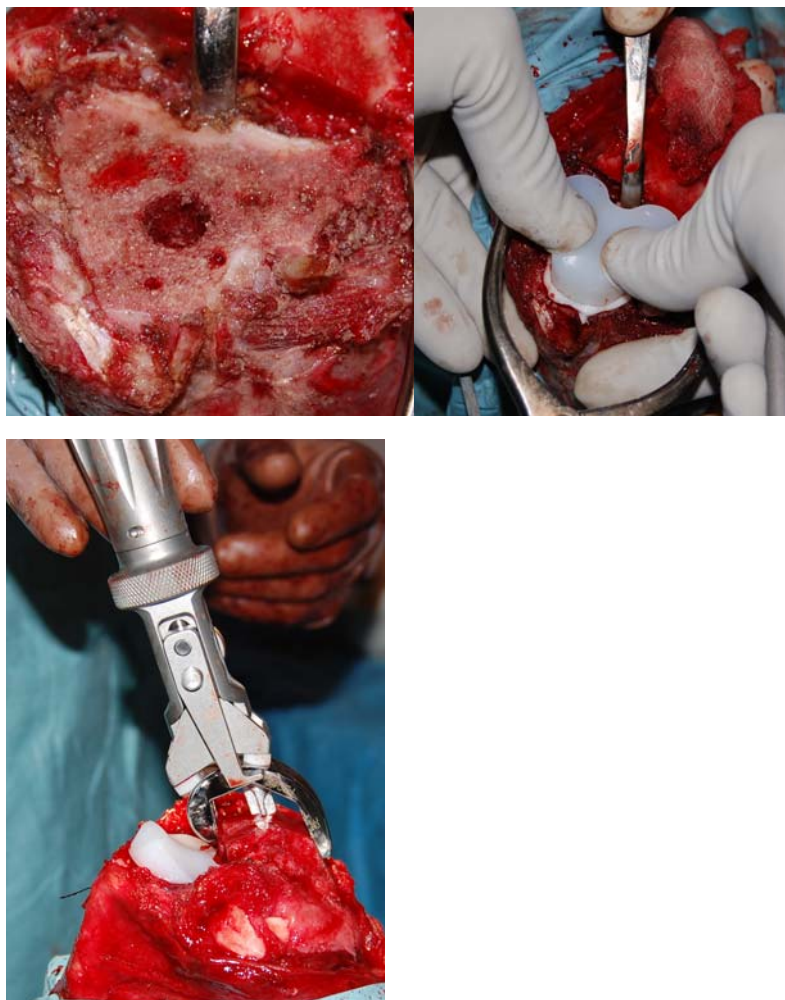
The proximal tibia is dissected free and released of attachments in order to make the tibial osteotomy. The tibial jig is aligned with the long axis of the tibial diaphysis to ensure that the cut is perpendicular to the flexion axis of the joint. Once the jig is attached to the tibia the top alignment plate can be further adjusted which influences the depth of the tibial plateau resected. There is also capability to control the effective tibial plateau slope of the cut. An oscillating saw is used to resect the proximal tibia. Care is taken to protect the patellar tendon and collateral ligaments. A series of trial tibial components are then applied to the cut surface of the tibia to select an appropriately sized implant for fixation. A medullary hole is drilled to accept the stem of the tibial implant. The tibial jig is then removed.

The femoral cutting guide is aligned on the femoral condyles. Two removable side arms are attached to the guide and used to secure the guide to the distal femur using K from both medial and lateral aspects. It is important to ensure that femoral cutting guide is aligned and secure. The oscillating saw is used to make cranial, caudal, distal and oblique femoral osteotomies. Osteotomised bone is removed. A trial femoral component is mounted and secured using force.



The knee is reduced and the patella repositioned within the trochlea of the femoral prosthesis. The joint is manually tested for range of motion, tightness and stability. Further soft-tissue releasing and or bone cuts may be required to improve extension or overcome medial fibrosis. If the joint is loose, the tibial trial component can be exchanged for a thicker component and assessment repeated. Achieving a balanced knee with no restrictions to motion yet no instability requires judgement and experience.

The trial components are removed and the definitive components implanted. The tibial surface is now prepared using medical grade peroxide to stop bleeding and the cancellous bone is foraged using a pin to improve cement intrusion. Polymethylmethacrylate (medical bone cement) is placed on the proximal tibia and the implant is cemented into place. The selected femoral component is press fit malleted into place using a custom handle that attaches to the femoral component. The joint is reduced and the joint capsule, fascia and skin closed routinely.



Postoperative Management

We have used two postoperative bandaging protocols. One group have received a modified Robert Jones for 3 days. The second group had an adhesive dressing with no overlying bandage applied. To date no significant difference was seen between the groups. At

this stage we are no longer applying Robert-Jones dressings in the immediate postoperative period.

Dogs stay in the clinic overnight and are monitored for pain and have their vital signs checked. They are walked outside to urinate and defecate. The dogs are discharged the following day with written instructions. They are rechecked if possible 3-4 days after discharge and then at the two week mark for suture removal. Radiographs of the prosthesis are taken at 4-6 weeks postoperatively.



Passive stifle extension exercises are shown to owners if the knee is held off the ground in flexion. Another useful technique is holding the front paws off the ground and this encourages the dog to weight bear and extend the hip and stifle concurrently. We call this the 'dancing' exercise.

Complications

Potential complications of TKR can include infection, aseptic loosening, collateral ligament damage, reduced range of motion, subluxation, nerve damage and haemorrhage. All surgical procedures carry risk and we believe that the success rate of this procedure will improve with experience.

Expected Outcomes

So far the dogs that we have performed TKR on have tolerated the surgical procedure and have improving limb use relative to their preoperative status. In some cases, the return to function is fast

with dogs significantly weight bearing within 7 days. Other dogs seem reluctant to start using their operated stifle, which may be habitual but more likely due to stiffness and pain. Aggressive physical therapy is likely to play a role in maximising limb use and enrolment of a physiotherapy program likely to be of benefit. We believe this is a procedure that will become accepted within the profession as a reliable treatment option for most dogs with non-infectious, non-neoplastic disabling osteoarthritis.



Cost

At the time of writing, knee, elbow and hip replacement surgery in Australia is about \$4000-6000 per joint. This reflects the advanced training, complexity of the procedure, follow-up rechecks and physiotherapy as well as the oncost of the implants.

PATELLAR LUXATION

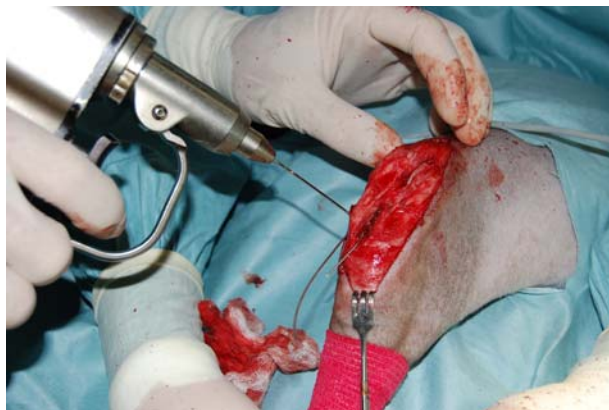
Medial patellar luxation is a common condition in Toy and small breeds and often present bilaterally. Little understanding of the exact etiology has been described other than altered conformation in some breeds. Grading scales are used as both communication tools and to guide use of treatment options. Displacement of the patella from the trochlea results in the initiation of degenerative changes and tends to be progressive. Chronic displacement increases the tensile stress placed on the ACL and concurrent or subsequent cruciate pathology and / or meniscal injury follows. Most orthopods recommend early corrective surgery to realign the quadriceps mechanism and minimise the rate and progression of secondary degenerative changes.



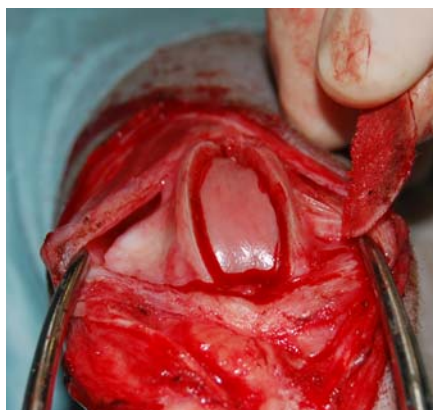
Numerous descriptions of surgical techniques are available to assist practitioners in improving their success rate. The level of difficulty varies greatly and caution should be exercised in both under and overcorrection. Clinicians must advise clients that recurrent luxation is one of the most common postoperative complications and that multiple surgeries may be required.

The following is a brief list of the most common procedures which the author uses in combinations to address MPL and LPL. Please note that not all techniques are applied to all cases every time and the 'art' in this surgery is to achieve a balance of both soft-tissue as well as osseous interventions and consistently maintain the patellar within the trochlear groove of the distal femur.

1. Medial joint capsular release is used when the patella is not able to be manually relocated into the trochlea groove. In advanced grade IV cases, extending the release proximally is required between the cranial sartorius and the medial vastus muscle bellies.
2. Lateral capsular resection or imbrication to overcome excessive / redundant tissue. It is especially important to resect capsule proximally as most patellas are unstable in extension.
3. Tibial crest / tuberosity transposition. The author prefers to isolate a large osseous fragment and preserve the distal insertion if possible. Pin (use two) and tension band wire fixation is recommended to limit problems with the transplanted ossicle (avulsion or loss of fixation). Rongeurs are useful to prepare a flat recipient bed for the graft to be secured to.



4. Sulcoplasty with preservation of articular cartilage. Although 'box' recession techniques that have recently been described offer the relative advantage of maximal cartilage preservation, the author performs a traditional wedge recession using hand or powered saw blades. It is recommended to resect a large osteochondral fragment rather than a shallow / narrow fragment.



5. Fabelotibial antirotational suture to limit excessive internal tibial rotation.
6. Imbrication of the fascia lata for medial luxations.

Correction of longbone deformities has become popular when it is felt that the bowing is excessive and making a contribution to malalignment of the quadriceps mechanism relative to the bone. *Genu varus* conformation is often due to distal femoral varus. True A-P femoral films are required to objectively measure any potential deformity and allow calculation of correction. A lateral closing wedge distal femoral osteotomy is a simple and effective intervention to address MPL in larger dogs with sufficiently deep grooves and no relative internal tibial crest rotation.



Decision making factors which influence a treatment plan should be considered. Staged or bilateral concurrent procedures also need to be decided upon. The advantages of concurrent limb surgeries include major cost savings, one anaesthesia period, a single period of convalescence and a shorted rehabilitation period. Increased risks of wound complications and implant failure are somewhat theoretical and have not been documented. Careful client selection is important and owners need to be able to both transport and support / assist animal patients. Inventive stifle / limb bandages / splints are useful to limit knee flexion in the early postoperative convalescence period.

The two most common errors in surgical treatment of patellar luxation surgery are:

1. Creation of too small a wedge recession resulting in minimal effective groove modification and
2. Failure to perform a tibial crest transposition and redirect the insertion of the quadriceps mechanism.



In the author's experience, improved clinical success can be attained by keeping an open mind when operating patellar luxation cases and not having a preconceived approach which does not change with the anatomic abnormalities which are present. It is ideal to approach the stifle and assess groove depth, relative tibial tubercle position, amount of rotational laxity between the femur and tibia, thickness and redundancy of both the medial and lateral joint capsule and the effect of cranial advancement of the fascia lata. Understand and utilize each of the above listed techniques as appropriate to the anatomic deformity rather than only using the ones you used last time. Patellar luxation surgery is challenging and rewarding.



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Carpus, Tarsus and Toes

Dr Chris Preston

Joint fusion is an accepted treatment option to salvage limb function in advanced cases of OA. The goal of surgery is to prevent biochemical and mechanical stimulation of nociceptors resulting from motion between degenerate articular surfaces and stretching of altered periarticular tissues which results in decreased pain perception and an improved quality of life. The indication for arthrodesis is chronic, disabling, medically-unresponsive, non-infectious, non-neoplastic joint pain. The most common indication is severe OA. Other indications include chronic luxations, distal neuropathies, severe deformity and complex joint fractures where development of severe OA is inevitable.



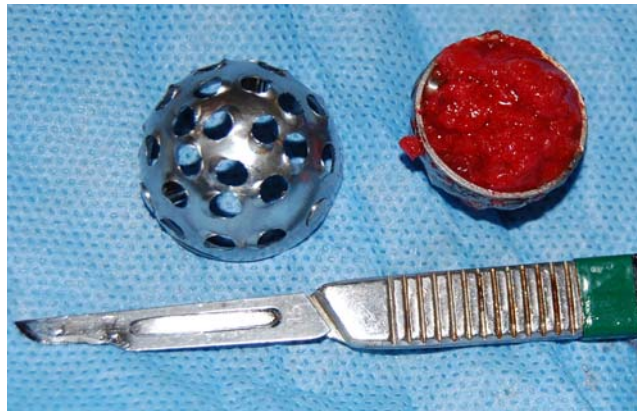
Of the major weight bearing joints, the shoulder, elbow, carpus, stifle and hock can be fused successfully. Although arthrodesis is a pain relief procedure, a residual mechanical lameness results which patient's must learn to accommodate. The more proximal the fusion, the more pronounced the disability. The shoulder is an exception to the basic rule because the scapula becomes more mobile on the trunk and so allows considerable movement to

replace normal shoulder motion. Arthrodesis of the more distal tarsal and carpal joints produces almost no visible change in gait. The hip is never fused, as excision arthroplasty is a more useful procedure.



The principles behind successful osseous bridging of a joint space include meticulous removal of articular cartilage from all joint levels to expose subchondral cancellous bone, placement of a large quantity of autogenous cancellous autograft, rigid internal fixation at a functional angle, supplemental limb coaptation (in most cases) to reduce implant failure complications and activity restriction for a prolonged period of time.





Bone plates and screw fixation is recommended as they offer superior strength and the ability to compress the contact areas across the fusion site compared to other fixation modalities. Osseous union usually takes several weeks. The most common complications include failure of fusion, fracture, infection, implant failure (screw loosening, plate fracture), wound dehiscence and poor limb use. Assuring that the joint is fused in the proper angle is fundamental to success because the angle chosen is the primary means of producing correct leg length. Due to the potential complications and the irreversibility of arthrodesis, this procedure is typically used as a treatment of last resort and as an alternative to amputation or total joint replacement surgery.

CARPAL HYPER-EXTENSION

Degeneration of the ligamentous supporting structures of the carpus occurs chronically in some dogs resulting in a relative palmargrade stance and a mechanical lameness. Secondary degenerative changes develop over time. Bilateral disease is common. Shelties and Collies are over-represented.



Stressed antebrachiocarpal radiographs are required under anaesthesia to establish a definitive diagnosis.

Typically there is loss of alignment at the carpometacarpal level and dorsal periosteal new bone production.

Elective pancarpal arthrodesis will restore athletic function if oral analgesics (NSAIDs) do not work.



HOCK OCD – ARTHROTOMY OR ARTHRODESIS?

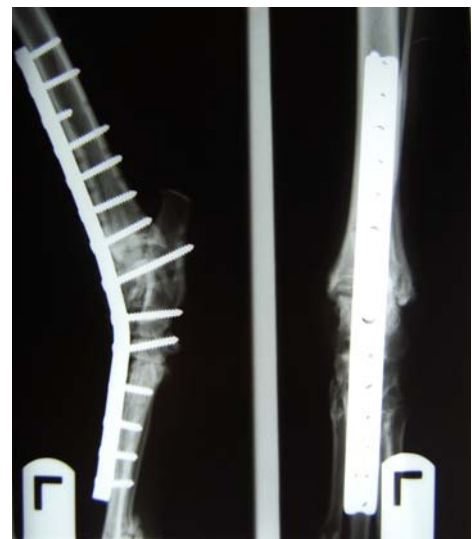
Osteochondrosis is a common condition affecting the shoulder, elbow, knee and tibiotarsal joint. Unfortunately the prognosis for hock OCD is poor and progressive osteoarthritis cannot be avoided. I believe that approx. 50% of canine patients will improve clinically in the short-term following early fragment removal. Although hock arthroscopy is possible, the joint is so small that arthroscopy is extremely difficult. I no longer offer hock arthroscopy and prefer open caudomedial or caudolateral arthrotomy. Typically the P-A view will reveal an increased medial joint space indicating excessively thick cartilage at the site of the lesion. Here we can see a calcified OCD flap consisting of diseased cartilage and underlying necrotic subchondral bone. A skyline radiograph may help identify the lesion.



To perform successful hock OCD surgery, the distal limb is flexed and a keyhole approach made to the respective condyle of the talus. The synovium is normally hypertrophic and inflamed and so electrocautery and suction are useful. Small sharp probes can be used to help identify and free the loose articular bodies. A large bearing surface defect will remain and client should be informed that progressive OA is expected.



If there are moderate degenerative changes in younger dogs that fail to improve with early surgery or the patient has been treated non-surgically and has advanced tibiotarsal osteoarthritis, elective tarsal arthrodesis is available. This can be achieved using plate fixation or alternatively a temporary external fixation frame can be used. This Whippet received a hybrid transarticular circular ESF frame after a failed Achilles tendon repair. Good function is achieved in most dogs as long as the angle of fusion is similar to the other side when the patient is standing.



SHEARING WOUNDS OF THE DISTAL LIMB

Abrasive distal extremity wounds can vary tremendously from mild cutaneous lacerations through to deep shearing injuries with loss of underlying bone and joint instability. Most of these wounds can be effectively managed using splints and wound treatments, surgical intervention is often not required. In some cases, delayed onset post-traumatic osteoarthritis will cause stiffness and dogs will progressively require more and more analgesia. Eventually elective arthrodesis may be required.

Here we see medial carpal shearing wounds that extended into the radiocarpal joints bilaterally. The attending veterinarian initially managed the case with systemic antibiotics and palmar fiberglass splinting. The wound healed but unfortunately, carpal arthritis developed. Circular ring fixators are useful in cases where infection is present. These frames offer great versatility and are eventually removed once healing is complete.

Fine K-wires are used to stabilize the metacarpal bones. Dogs can walk immediately postop. This patient sustained open medial hock trauma and had medial collateral ligament reconstruction using three screws to anchor suture. This patient deteriorated over eight years and eventually had a hinged circular ESF placed after the infected screws were removed.





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